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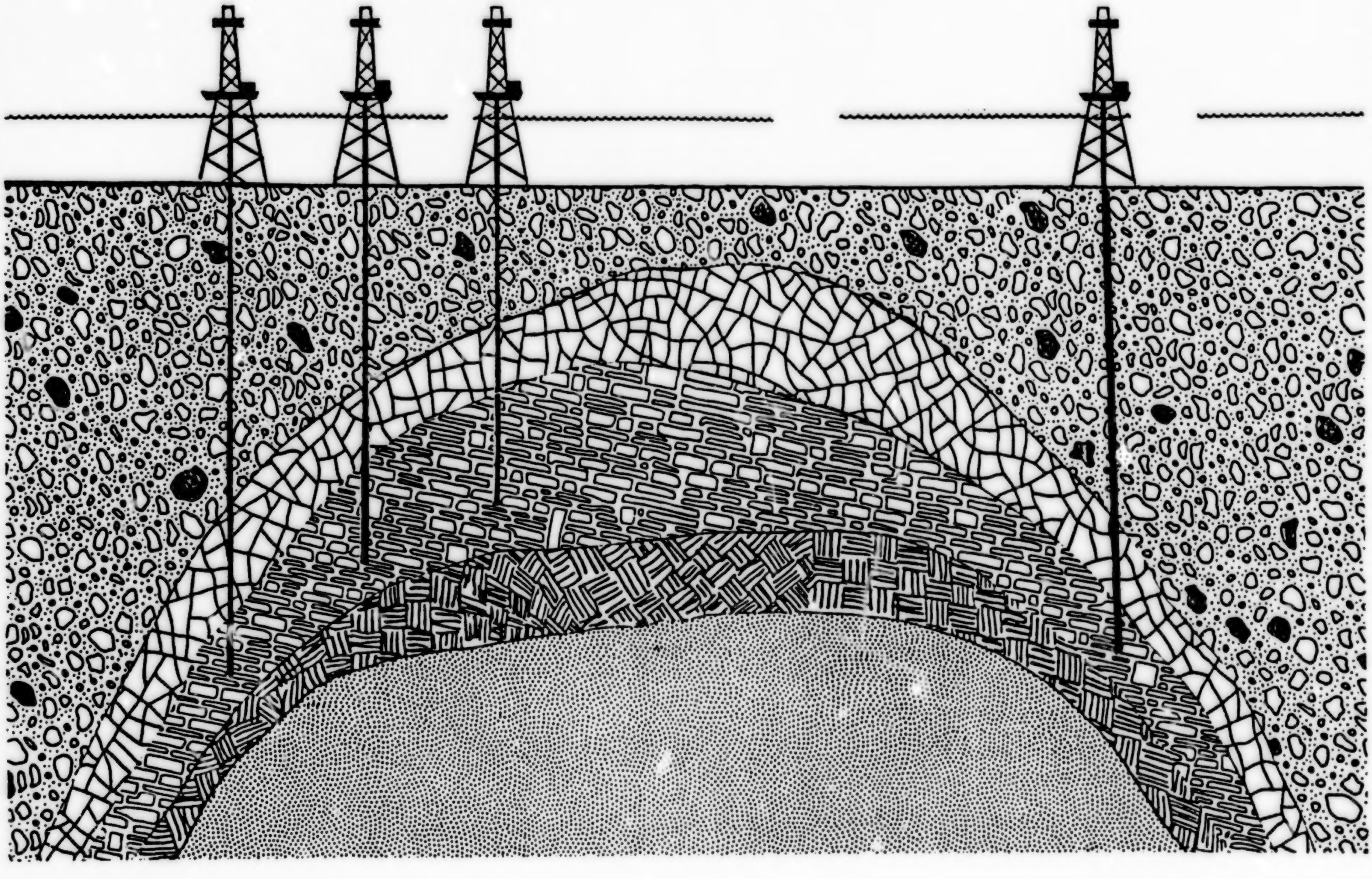
MMS 87-0034

Gulf of Mexico
Outer Continental Shelf

Proposed Central Gulf of Mexico Sulphur/Salt Lease Sale

Environmental Assessment



MMS
U.S. Department of the Interior
Minerals Management Service
Gulf of Mexico OCS Regional Office

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U.S. Department of the Interior
Minerals Management Service
Gulf of Mexico OCS Regional Office

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I

SUMMARY

1. The Proposed Action

The proposed action is to offer for sulphur/salt lease 153 nominated tracts in 51 bidding units in the Central Gulf of Mexico which amounts to about 725,000 acres. The tracts offered in this proposed sale range from 3 to 95 miles offshore in water depths that range from 5-160 meters (m).

Basic assumptions, estimates, and the development scenario for impact analysis of the proposed action are presented in Section IV.A. The development scenario for the proposed action provides a quantitative and locational framework for the proposed sale, and alternatives are also used along with other impact producing factors in the cumulative analysis. Only the Most Likely Find Scenario (M Scenario) was used for this analysis. Table S-1 provides resource and offshore infrastructure estimates for the M Scenario.

2. Issues and Areas of Concern

As authorized by the Outer Continental Shelf Lands Act (OCSLA), as amended, the Department of Interior (DOI), through the Minerals Management Service (MMS), serves as the Federal agency administering such sales. In addition, MMS coordinates, as appropriate, with many cooperating Federal, State, and nongovernmental groups and organizations to obtain resource information and to identify concerns.

Due to the nature and uniqueness of the proposed action, and in keeping with the spirit of the National Environmental Policy Act (NEPA) and Council on Environmental Quality (CEQ) guidelines, MMS contacted and coordinated with Federal, State, and local governments, institutions, public interest groups, and concerned individuals during the scoping process and EA preparation for the purpose of identifying environmental concerns, issues, and alternatives to be considered in the analysis. A number of potential environmental concerns and issues were identified through scoping. Of these, the following were deemed by MMS as significant:

- Sensitive Coastal Habitats
  - Barrier Beaches/Islands
  - Wetlands
- Sensitive Offshore Habitats
- Water Quality
- Air Quality
- Endangered and Threatened Species
  - Brown Pelicans
  - Sea Turtles
- Marine Mammals (Whales)
- Coastal and Marine Birds
- Adjacent-Existing Oil and Gas Operations
- Commercial Fishing Industry
- Major Shorefront Recreational Beaches
- Archaeological Resources
  - Historic
  - Prehistoric
- Socioeconomic Impacts

Table S-2 provides a summary of the impact levels on each resource category expected to result from the proposed action and the cumulative impact levels expected to result from the proposed action plus all other impact producing factors. Definitions of the impact levels for each resource category are shown in Table S-3.

3. Alternatives

Besides Alternative A, the proposed action, five other alternatives were considered in this analysis, which are discussed in Section II and are summarized below:

Alternative B (Delete Tracts with Active Oil and Gas Leases)

This alternative would delete 125 tracts which have active oil and gas leases.

Alternative C (Delete Tracts with Pipelines)

This alternative would delete 128 tracts which contain oil or gas pipelines.

Alternative D (Delete Military Areas)

This alternative would delete one tract which occurs in a military water test area.

Alternative E (Delay the Sale)

This alternative would delay any impacts resulting from the proposed action, but would not change those impacts.

Alternative F (No Action)

This alternative equates to cancellation of the sale. Impacts resulting from the exploration, development, and production of sulphur would not occur. Other potential sources for sulphur would have to be sought to replace any lost production resulting from this alternative.

Table S-1

Resource and Offshore Infrastructure Estimates: Sulphur/Salt Sale

Number of Bidding Units Offered	51
Number of Blocks Offered	153
Acreage Offered (thousands of acres)	725
Resources Expected to be Developed	
Sulphur (millions of long tons)	55
Salt (millions of short tons)	15
Offshore Infrastructure	
Exploration and Delineation Wells	60
Power Plant Platforms (1 per mine)	3
Production Platforms	9
Auxillary Platforms	6
Development Wells	324
Sidetrack Wells	576
Salt Wells	3
Bleedwater Wells	120
Gas Pipelines (for fuel-number/miles)	3/30
Water Pipelines (number/miles)	1/10
Sulphur Pipelines	0
Brine Pipelines (number/miles)	3/3

Source: USDI, Minerals Management Service, Gulf of Mexico OCS Region estimates.

Table S-2

Comparison and Summary of Impact Levels[1] for Alternatives A-F in the Central Planning Area Sulphur/Salt Sale

Resource Category	Alternative A M Scenario[2]	Cumulative[3]	Alternatives B[4]	C[5]	D[6]	E[7]	F[8]
Sensitive Coastal Habitats							
Barrier Beaches/Islands	VL	VH	VL	VL	VL	VL	NE
Wetlands	VL	VH	VL	VL	VL	VL	NE
Sensitive Offshore Habitats							
High Topographic Features	VL	VL	VL	VL	VL	VL	NE
Live Bottom Areas	NE	VL	NE	NE	NE	NE	NE
Water Quality	L*	H	VL	VL	L	L	NE
Air Quality	L	M	L	L	L	L	NE
Endangered and Threatened Species							
Brown Pelicans	VL	M	VL	VL	VL	VL	NE
Sea Turtles	VL	VH	VL	VL	VL	VL	NE
Marine Mammals	VL	H	VL	VL	VL	VL	NE
Coastal and Marine Birds	VL	M	VL	VL	VL	VL	NE
Commercial Fishing Industry	VL	H	VL	VL	VL	VL	NE
Existing Oil and Gas Operations	VL	VH	NE	VL	VL	VL	NE
Major Shorefront Recreational Beaches	VL	H	VL	VL	VL	VL	NE
Archaeological Resources							
Historic	VL**	VH	VL**	VL**	VL**	VL**	NE
Prehistoric	VL	VH	VL	VL	VL	VL	NE
Socioeconomics	VL	VL	VL	VL	VL	VL	NE

VH - Very High
H - High
M - Moderate
L - Low
VL - Very Low
NE - No Effect

[1] For definitions of levels of impacts, see Table S-3.

[2] Alternative A - (Proposed Action) based on the M Scenario.

[3] Alternative A - (Proposed Action) based on cumulative impacts of all activities.

[4] Alternative B - Delete Active Oil and Gas Leases.

[5] Alternative C - Delete Tracts with Pipelines.

[6] Alternative D - Delete Military Areas.

[7] Alternative E - Delay the Sale.

[8] Alternative F - No Action.

*Some of the coastal counties/parishes have very low impacts. See Section IV.C.1.c. for specific counties/parishes.

**The impact level listed is for subplanning areas C-1 and C-4. The impact level for subplanning areas C-2 and C-3 is uncertain, but could be very high. Although the impact if an interaction occurred could be very high, the probability of such an interaction is very low in view of the evaluations afforded by the information generated under the requirements of NTL 75-3 (Revision No. 1) and other sources.

Table S-3

Definitions Assumed in Impact Assessment

	Very High	High	Moderate	Low	Very Low
Sensitive Coastal Habitats	Very severe long-term adverse effects: more than 2% of the habitat area destroyed or altered; or loss/interference due to oil spill contacts with sensitive coastal habitats (4 or more).	Major long-term adverse effects. 1%-2% of the habitat area destroyed or altered; or loss/interference due to oil spill contacts with sensitive coastal habitats (2-3).	Moderate adverse effects: 0.25%-1% of the habitat area destroyed or altered; or loss/interference due to oil spill contacts with sensitive coastal habitats (1).	Minor adverse effects: 0.02%-0.25% of the habitat area destroyed or altered; no spill contacts with sensitive coastal habitats.	Negligible to minor effects: 0.02% or less of the habitat area destroyed or altered; no spill contacts with sensitive coastal habitats.
Sensitive Offshore Habitats					
a. Topographic Features (Central and Western Gulf only)	A species or population or a substantial portion of a topographic feature's biologic community or assemblage will be harmed to the extent that recovery of that particular entity may not occur.	A significant interference with ecological relationships. This usually involves the mortality or a biological alteration of a noticeable segment of the population, community, or assemblage. Recovery may occur.	A short-term interference with ecological relationships. Although some species may sustain substantial losses, other species will sustain low losses, and the ecological mix will not be altered.	A few species may sustain low losses, but any interference with ecological relationships will not be evident.	Loss of a few individuals but no interference with ecological relationships.
b. Live Bottoms (Pinnacle Trend) (Central Gulf only)	Substantial and permanent destruction of a large portion of the pinnacle environment and the assemblage thereon.	Mortality of the pinnacle community and destruction of the environment such that recovery is long-term (greater than one year).	Substantial damage to a localized area. Recovery may be precluded or long-term.	Short-term interference with ecological relationships. Recovery is short-term (less than one year).	Localized short-term interference with ecological relationships.
Water Quality	Water quality parameters change significantly by several orders of magnitude; toxic trace metals or hydrocarbons exceed USEPA safe levels; changes persist for months or longer.	Water quality parameters change significantly by one or two orders of magnitude, toxic trace metals or hydrocarbons near USEPA safe levels; changes persist for days to weeks.	Statistically significant changes in water quality parameters which persist for several weeks.	Some measures of water quality deviate significantly from ambient measures but are quickly (within 1-2 days) restored to normal.	Normal measures of water quality such as oxygen content, salinity, temperature, transmittance, trace metal concentrations, and hydrocarbon levels show no statistically significant changes from ambient conditions.
Air Quality	OCS-related offshore or onshore sources significantly increase levels of criteria pollutants such that nonattainment areas will be degraded further or attainment and PSD areas are significantly degraded.* Significant effects on public health and welfare are expected.	OCS-related offshore or onshore sources increase levels of criteria pollutants such that nonattainment areas are likely to be degraded less than significantly, or attainment and PSD areas are likely to degrade.* Likely to pose hazards to public health and welfare.	OCS-related offshore or onshore sources increase levels of criteria pollutants such that nonattainment areas are likely to experience minor degradation and attainment and PSD areas are not likely to degrade significantly.* Unlikely to pose hazards to public health and welfare.	OCS-related offshore or onshore sources increase levels of criteria pollutants such that nonattainment areas are unlikely to be degraded further and attainment and PSD areas are likely to undergo only very small increases in levels of criteria pollutsnts.* Very unlikely to pose hazards to public health and welfare.	OCS-related offshore or onshore sources increase levels of criteria pollutants such that nonattainment areas are very unlikely to be degraded further and attainment and PSD areas are likely to undergo negligible increases in levels of criteria pollutants.* Does not pose any hazard to public health and welfare.
Endangered and Threatened Species	A population declines in the affected area, resulting in a change in the distribution and/or abundance (greater than 5%) of the species in the local area and/or the planning area. The expected duration of the effects within the local area and/or the planning area is more than three generations** or 10 years or more.	A population declines in the affected area, resulting in a change in the distribution and/or abundance (less than or equal to 5%) of the species in the local area and/or the planning area. The expected duration of the effects within the local area and/or the planning area is two or three generations or 6-9 years.	A population declines in the affected area, resulting in a change in the distribution and/or abundance (less than or equal to 1%) of the species in the local area and/or the planning area. The expected duration of the effects within the local area and/or the planning area is one generation or 3-5 years.	A population declines in the affected area, resulting in a change in the distribution and/or abundnace of the species in the local area and/or the planning area. The expected duration of the effects within the local area and/or the planning area is less than one generation or 1-3 years.	No discernible lethal effects, but individuals experience sublethal effects which cause reduced biogenic activity or reduced metabolic functions. Organisms would recover to pre-impact condition in less than one generation or 1-2 years.

Table S-3. Definitions Assumed in Impact Assessment (continued)

	Very High	High	Moderate	Low	Very Low
Marine Mammals (Endangered & Nonendangered)	A population declines in the affected area, resulting in a change in the distribution and/or abundance of the species in the local area and/or the planning area. The expected duration of the effects within the local area and/or the planning area is more than three generations** or 10 years or more.	A population declines in the affected area, resulting in a change in the distribution and/or abundance of the species in the local area and/or the planning area. The expected duration of the effects within the local area and/or the planning area is two or three generations or 6-9 years.	A population declines in the affected area, resulting in a change in the distribution and/or abundance of the species in the local area and/or the planning area. The expected duration of the effects within the local area and/or the planning area is one generation or 3-5 years.	A population declines in the affected area, resulting in a change in the distribution and/or abundance of the species in the local area and/or the planning area. The expected duration of the effects within the local area and/or the planning area is less than one generation or 1-3 years.	No discernible lethal effects, but individuals experience sublethal effects which cause reduced biogenic activity or reduced metabolic functions. Organisms would recover to pre-impact condition within one generation or 1-2 years.
Coastal and Marine Birds	A population declines in the affected area, resulting in a change in the distribution and/or abundance of the species in the local area and/or the planning area. The expected duration of the effects within the local areas and/or the planning area is more than three generations** or 10 years or more.	A population declines in the affected area, resulting in a change in the distribution and/or abundance of the species in the local area and/or the planning area. The expected duration of the effects within the local area and/or the planning area is two or three generations or 6-9 years.	A population declines in the affected area, resulting in a change in the distribution and/or abundance of the species in the local area and/or the planning area. The expected duration of the effects within the local area and/or the planning area is one generation or 3-5 years.	A population declines in the affected area, resulting in a change in the distribution and/or abundance of the species in the local area and/or the planning area. The expected duration of the effects within the local area and/or the planning area is less than one generation or 1-3 years.	No discernible lethal effects, but individuals experience sublethal effects which cause reduced biogenic activity or reduced metabolic functions. Organisms would recover to preimpact condition in less than one generation or 1-2 years.
Adjacent Existing Oil and Gas Operations	Major damage to, or the total loss of one or more platforms, or the failure of one or more major pipelines, which results in serious injury or loss of life, a major oil spill, and total replacement of the structure(s) or pipelines(s).	Major damage to, or the total loss of a platform, or the failure of a major pipeline, which may result in injury, a small to moderate oil spill, and total replacement of the platform or pipeline. Down time would be lengthy.	Damage to a platform or pipeline which may result in minor injury, a small oil spill, high expense to repair or replace, and a lengthy period of down time.	Minor damage to a platform or pipeline which results in no injury or loss of life, little or no oil spilled, moderate expense to repair, and down time of short to moderate duration.	Minor damage to a platform or pipeline which results in no injury or loss of life, no oil spilled, minor expense to repair, and little or no down time.
Commercial Fishing Industry	An economic loss of greater than 5% to the commercial fishing industry, many fishermen out of work, and secondary employment (processing plants, etc.) substantially affected.	A 1%-5% economic loss to the commercial fishing industry, some fishermen out of work, and secondary employment affected.	A 0.1%-1% economic loss to the commercial fishing industry, some financial loss to fishermen, and secondary employment affected.	A 0.01%-0.1% economic loss to the commercial fishing industry, some fishermen affected, but no effect on secondary employment.	A 0.01% or less estimated loss to the commercial fishing industry, and a few fishermen affected.
Major Shorefront Recreational Beaches	The overall quantity of major recreational beaches in the region will permanently change and/or a persistent change in the quality of a majority of the major beaches will be evident.	The quality of a small percentage (those associated with at least one community) or major recreational beaches in the region will be permanently affected. Sustained influence (one or more years) on the type and intensity of beach-related recreational activities is expected to influence regional and subregional displacement of recreational use.	The quality of a large percentage (more than one community or political subdivision) of the major recreational beach environment is minimal yet perceivably affected in a sustained manner, yet the level and type of recreational activity is not changed. Acute, short-term damage to individual beaches can occur.	The quantity or quality of the major recreational beach environment does not change in a perceptible or sustained manner either regionally or subregionally; acute, short-term damage to individual recreational beaches is slight; and the influence on one or more beach-related recreational activities is not major.	The quantity and quality of major recreational beaches does not change; short-term damage to individual recreational beaches is negligible. Impacts do not preclude recreational use, although they may cause minor inconveniences to local users or site administrators.

Table S-3. Definitions Assumed in Impact Assessment (continued)

	Very High	High	Moderate	Low	Very Low
Archaeological Resources	An interaction between an archaeological site and an impact producing factor occurs and results in the loss of unique archaeological information.	An interaction between an archaeological site and an impact producing factor occurs and results in the loss of significant,*** but not unique, archaeological information.	An interaction between an archaeological site and an impact producing factor occurs and results in the loss of archaeological data that are not significant.***	An interaction between an archaeological site and an impact producing factor occurs, but impacts are temporary and reversible.	Little damaging interaction between an impact producing factor and an archaeological site occurs.
Socioeconomic Impacts	10% or greater annual growth in employment/payroll/population.	7%-9% annual growth in employment/payroll/population.	4%-6% annual growth in employment/payroll/population.	2%-3% annual growth in employment/payroll/population.	1% or less annual growth in employment/payroll/population.

*Note that levels of degradation of PSD areas are relative to whether they are a Class I, Class II, or Class III area; i.e., very small changes in pollutant levels are considered significant for Class I areas. (See Tables IV-8 and IV-9 for significant levels.)

**A generation is the term of years accepted as the average period between the birth of the parents and the birth of their offspring.

***Significance as per National Register criteria.

CONTENTS

Page

SUMMARY i

TABLES xv

FIGURES xvii

ABBREVIATIONS AND ACRONYMS xix

I. DESCRIPTION OF THE PROPOSED ACTION 1

A. PURPOSE AND NEED OF THE PROPOSED ACTION 1

B. BACKGROUND OF THE PROPOSED ACTION 1

1. Administrative Events Leading to the Proposed Action 1

2. Regulatory and Administrative Framework - Department of the Interior 3
- a. Presale Activity 3
  - (1) Federal/State Coordination 3
  - (2) Geological and Geophysical Activity Regulations/Coordination 3
- b. Postsale Activity Regulation/Coordination 4
  - (1) Review, Coordination, and Approval of Exploration, Development and Production Activities 4
  - (2) Regulatory Enforcement Measures 5
    - (a) Inspections 5
    - (b) Special Inspection Procedures 6
    - (c) Suspension of Operations and Cancellation of Leases 6
    - (d) Remedies and Penalties 6
  - (3) Environmental Safeguards 7
    - (a) Notice to Lessees and Operators (NTL) 83-3 Concerning Shallow Hazards for the Gulf of Mexico OCS Region 7
    - (b) OCS Orders 7
    - (c) Lease Stipulations 8
    - (d) Air Quality 8
    - (e) Best Available and Safest Technology 8
    - (f) Pipelines 9
    - (g) Other Environmental Safety Controls 9
  - (4) Regional Technical Working Group 10

3. Other Federal Agency Regulatory/Administrative Measures 10
- a. Navigation 10
- b. OCS Pipelines 11
- c. Coastal Zone Management 11
- d. Archaelogical Resources Legislation 11
- e. Endangered Species Act of 1973 12
- f. Marine Mammal Protection Act of 1972 12

- g. Fishery Conservation and Management Act of 1976 12
- h. National Fishing Enhancement Act of 1984 12
- i. Executive Order 11990, Protection of Wetlands 13
- j. Ports and Waterways Safety Act 13

4. Regulations Governing Discharges 13

5. Interrelationship with Other Programs and Proposals 16
   - a. OCS Oil and Gas Program 16
   - b. Estuarine and Marine Sanctuaries 16
   - c. Deepwater Ports 17
   - d. Offshore Mining 17
   - e. Ocean Dumping 18
   - f. Ocean Incineration 18
   - g. Dredge Material 18
   - h. National Defense 18
   - i. Louisiana Artificial Reef Program 19

II. ALTERNATIVES INCLUDING THE PROPOSED ACTION 21

A. ALTERNATIVE A - THE PROPOSED ACTION 21

1. Description of the Proposed Action 21

2. Summary of Impacts 22
   - a. Impacts on Sensitive Coastal Habitats 22
     - (1) Barrier Beaches/Islands 22
     - (2) Wetlands 22
   - b. Impacts on Sensitive Offshore Habitats 22
   - c. Impacts on Water Quality 22
   - d. Impacts on Air Quality 23
   - e. Impacts on Endangered and Threatened Species 23
     - (1) Brown Pelicans 23
     - (2) Sea Turtles 23
   - f. Impacts on Marine Mammals (Whales) 23
   - g. Impacts on Coastal and Marine Birds 24
   - h. Impacts on Adjacent Existing Oil and Gas Operations 24
   - i. Impacts on the Commercial Fishing Industry 24
   - j. Impacts on Major Shorefront Recreational Beaches 24
   - k. Impacts on Archaeological Resources 24
     - (1) Historic 24
     - (2) Prehistoric 25
   - l. Socioeconomic Impacts 25

3. Proposed Mitigating Measures 25
   - a. Archaeological Resource Stipulation 26
   - b. Military Areas Stipulation 27
   - c. Operational Constraints 29

B. ALTERNATIVE B - DELETE TRACTS WITH ACTIVE OIL AND GAS LEASES 30

1. Description of the Alternative 30

2. Summary of Impacts 31

C. ALTERNATIVE C - DELETE TRACTS WITH PIPELINES 31
  1. Description of the Alternative 31
  2. Summary of Impacts 32
D. ALTERNATIVE D - DELETE MILITARY AREAS 32
  1. Description of the Alternative 32
  2. Summary of Impacts 32
E. ALTERNATIVE E - DELAY THE SALE 32
  1. Description of the Alternative 32
  2. Summary of Impacts 32
F. ALTERNATIVE F - NO ACTION 32
  1. Description of the Alternative 32
  2. Summary of Impacts 32
G. COMPARISON OF ALTERNATIVES 33

III. DESCRIPTION OF THE AFFECTED ENVIRONMENT 35
A. PHYSICAL ELEMENTS OF THE ENVIRONMENT 35
  1. Environmental Geology and Hazards 35
    a. Geology (and the Formation of Cap Rock Sulphur) 35
    b. Geologic Hazards 36
    c. Non-Sulphur/Salt Mineral Resources 36
  2. Meteorological Conditions 36
  3. Physical Oceanography 36
  4. Chemical Oceanography 37
  5. Water Quality 37
  6. Air Quality 39
B. BIOLOGICAL RESOURCES 39
  1. Coastal Habitats 39
    a. Barrier Beaches/Islands 39
    b. Wetlands 42
  2. Offshore Habitats 43

3. Endangered and Threatened Species 43

4. Other Wildlife Species 45
    a. Marine Mammals 45
    b. Coastal and Marine Birds 45

5. Commercial Fisheries 45

C. SOCIOECONOMIC CONDITIONS AND OTHER CONSIDERATIONS 47

1. Employment 48

2. Income 51

3. Population 51

4. Coastal Management Programs 54

5. Oil and Gas Industry 54

6. Sulphur Industry 55

7. Ports and Marine Transportation 57

8. Commercial Fishing Industry 57

9. Recreational Activities 58

10. Military Use/Warning Areas 61

11. Archaeological Resources 61
    a. Historic 61
    b. Prehistoric 62

12. Water Supply 63

IV. ENVIRONMENTAL CONSEQUENCES 65

A. DEVELOPMENT SCENARIOS 65

1. Proposed Action: Most Likely Find Scenario (M Scenario) 65
    a. Resource and Offshore Infrastructure Estimates 65

2. Cumulative Activities (Cumulative Scenarios for the Proposed Action) 67
    a. Cumulative Scenario Factors Related to the Proposed Action and Prior and Future OCS Sulphur/Salt Lease Sales 67
    b. Offshore Oil and Gas Activity in the Central Gulf 67
    c. Other Major Offshore Activities 69
    d. Major Onshore Activities in Coastal Areas 69

3. Impact Producing Factors Related to Routine Offshore Support Activities 69
    a. Effluent Discharges 69
    b. Air Emissions 77
    c. Noise Emissions 78

- d. Physical Presence of Drilling Rigs, Platforms, Boats, and Barges 79
- e. Accidental Sulphur Spills 80
- f. Subsidence 81
- g. Ancillary Pipeline Construction 81
- h. Dredging Activities 82
- i. Seismic Operations 82
- j. Trash and Debris 83
- k. Oil Spills 83
  - (1) Historic Spill Rates Associated with Sulphur Mining 83
  - (2) Chronic or Long-term Oil Pollution 83
    - (a) Sources of Hydrocarbon Inputs into the Gulf of Mexico 83
    - (b) Sublethal and Long-term Effects of Chronic or Low-level Oil Pollution 84
  - (3) Catastrophic Oil Spills (Blowouts) 84
  - (4) Oil Spill Containment/Cleanup Capabilities and Effectiveness 84
    - (a) Equipment Locations 85
    - (b) Equipment Effectiveness 86
- l. Anchoring 86
- m. Platform Removal or Relocation 86

B. ITEMS OF SPECIAL CONCERN 87

1. Hazardous Conditions 87

2. Blowouts 87

C. ENVIRONMENTAL IMPACTS OF THE PROPOSED ACTION AND ALTERNATIVES 89

1. Impacts from Alternative A - The Proposed Action 89
   - a. Impacts on Sensitive Coastal Habitats 89
     - (1) Barrier Beaches/Islands 89
     - (2) Wetlands 91
   - b. Impacts on Sensitive Offshore Habitats 94
     - (1) Topographic Features 94
     - (2) Live Bottoms 95
   - c. Impacts on Water Quality 96
   - d. Impacts on Air Quality 99
   - e. Impacts on Endangered and Threatened Species 104
     - (1) Brown Pelicans 104
     - (2) Sea Turtles 106
   - f. Impacts on Marine Mammals (Whales) 107
   - g. Impacts on Coastal and Marine Birds 109
   - h. Impacts on Existing Oil and Gas Operations 111
   - i. Impacts on the Commercial Fishing Industry 126
   - j. Impacts on Major Shorefront Recreational Beaches 128
   - k. Impacts on Archaeological Resources 129
     - (1) Historic 129
     - (2) Prehistoric 132
   - l. Socioeconomic Impacts 134

2. Impacts from Alternative B - Delete Tracts with Active Oil and Gas Leases 136

3. Impacts from Alternative C - Delete Tracts with Pipelines 136

4. Impacts From Alternative D - Delete Military Areas 136

5. Impacts from Alternative E - Delay the Sale 137

6. Impacts from Alternative F - No Action 137

V. CONSULTATION AND COORDINATION 139

A. DEVELOPMENT OF THE PROPOSED ACTION 139

B. DEVELOPMENT OF THE ENVIRONMENTAL ASSESSMENT 139

VI. BIBLIOGRAPHY AND SPECIAL REFERENCES 145

VII. PREPARERS 157

VIII. APPENDICES 159

A. PHYSICAL PROPERTIES OF ELEMENTAL SULPHUR 159

B. DESCRIPTION OF THE FRASCH-MINING PROCESS FOR SULPHUR 163

C. DESCRIPTION OF EXISTING OFFSHORE SULPHUR MINES 167

D. SULPHUR USES 171

TABLES

		Page
Table S-1	Resource and Offshore Infrastructure Estimates: Sulphur/Salt Sale	iii
Table S-2	Comparison and Summary of Impact Levels for Alternatives A-F in the Central Planning Area Sulphur/Salt Sale	iv
Table S-3	Definitions Assumed in Impact Assessment	v
Table I-1	Bidding Units - Proposed Sulphur/Salt Lease Sale	2
Table III-1	Range of General Water Quality Values for Offshore Freeport, Texas, and West Louisiana Coastal Waters	38
Table III-2	Nonattainment and PSD Class I Areas throughout the Gulf Coastal Region	41
Table III-3	Labor Force Data/Gulf of Mexico Region	49
Table III-4	Employment by Major Industry Group/Central Gulf of Mexico - 1984 Percent of Total	50
Table III-5	Employment by Major Industry Group/Western Gulf of Mexico - 1984 Percent of Total	50
Table III-6	Income Data of Coastal Counties in the Gulf of Mexico Region	52
Table III-7	Population Data of Coastal Counties in the Gulf of Mexico Region	53
Table III-8	Commercial Landings (1985)	59
Table III-9	Catch by Bay System	60
Table IV-1	Exploration, Development, and Production Assumption/Estimates	66
Table IV-2	Estimated Oil and Gas Activity, Infrastructure, and Related Major Impact Producing Factors in the Central Gulf: 1988-2023	70
Table IV-3	Comparison of Seawater and Untreated Bleedwater	74
Table IV-4	Typical Emissions for Exploratory Drilling Activity in the Gulf of Mexico (tons)	78
Table IV-5	Average Annual Emissions from Platforms in the Gulf of Mexico (tons/year/platform)	78
Table IV-6	Availability of Oil Spill Cleanup	85
Table IV-7	Blowouts in the Gulf of Mexico, 1979-1984	88
Table IV-8	Ambient Air Pollutant Concentrations	100
Table IV-9	Air Quality - Maximum Allowable Increase	101
Table IV-10	Average Annual Air Emissions Under M Scenario Assumptions (tons/year)	102
Table IV-11	Cumulative OCS Offshore Average Annual Air Emission Estimates	103
Table IV-12	Potential Impact Levels to Existing Oil and Gas Infrastructure	125

FIGURES

		Page
Figure III-1	Areas of Concern with Respect to Point and Nonpoint Source Pollution within the Central and Western Gulf of Mexico	40
Figure III-2	Banks of the Northwestern Gulf of Mexico	44
Figure IV-1	Generalized Layout of a Typical Sulphur Mine Expected to Result from the Sale	68
Figure IV-2	Existing Oil and Gas Infrastructure - West Cameron Area Tracts	112
Figure IV-3	Existing Oil and Gas Infrastructure - East Cameron/West Cameron Area Tracts	113
Figure IV-4	Existing Oil and Gas Infrastructure - East Cameron/West Cameron Area Tracts	114
Figure IV-5	Existing Oil and Gas Infrastructure - Vermilion Area Tracts	115
Figure IV-6	Existing Oil and Gas Infrastructure - South Marsh Island Area Tracts	116
Figure IV-7	Existing Oil and Gas Infrastructure - Eugene Island Area Tracts	117
Figure IV-8	Existing Oil and Gas Infrastructure - Eugene Island Area Tracts	118
Figure IV-9	Existing Oil and Gas Infrastructure - Ship Shoal/Eugene Island Area Tracts	119
Figure IV-10	Existing Oil and Gas Infrastructure - Ship Shoal Area Tracts	120
Figure IV-11	Existing Oil and Gas Infrastructure - South Pelto/South Timbalier/Grand Isle Area Tracts	121
Figure IV-12	Existing Oil and Gas Infrastructure - West Delta/Mississippi Canyon/South Pass Area Tracts	122
Figure IV-13	Existing Oil and Gas Infrastructure - Main Pass/South Pass Area Tracts	123
Figure B-1	The Frasch-Mining Process for Sulphur	166

ABBREVIATIONS AND ACRONYMS

ACAA	Alabama Coastal Area Act of 1976
ACAMP	Alabama Coastal Area Management Program
ACB	Air Control Board (Texas)
ADAPTS	Air Deliverable Anti-Pollution Transfer System
AEC	Atomic Energy Commission
AEMA	Alabama Environmental Management Act
AI	Area Identification
APD	Application for Permit to Drill
BAST	Best Available and Safest Technology
bbls	barrels
BEA	Bureau of Economic Analysis
BLM	Bureau of Land Management
BOA	Basic Ordering Agreement
BOD	biological oxygen demand
BMR	Bureau of Marine Resources (Mississippi)
B.P.	before present
C	Centigrade
Call	Call for Information and Nominations
CEI	Coastal Environments, Inc.
CEQ	Council on Environmental Quality
CER	categorical exclusion review
CERCLA	Comprehensive Environmental Compensation and Liability Act
CFR	Code of Federal Regulations
CGA	Clean Gulf Associates
cm	centimeter
CMP	coastal management program
CO	Carbon Monoxide
COE	Corps of Engineers
COPRDM	Committee on Ocean Pollution Research, Development, and Monitoring
CPA	Central Planning Area
CSA	Continental Shelf Associates
CZM	Coastal Zone Management
CZMA	Coastal Zone Management Act
dBa	decibel
DECA	Department of Economic and Community Affairs (Alabama)
DEM	Department of Environmental Management (Alabama)
DM	Departmental Manual
DMA	Defense Mapping Agency
DO	dissolved oxygen
DOC	Department of Commerce
DOCD	Development Operations Coordination Document
DOD	Department of Defense
DOE	Department of Energy
DOI	Department of the Interior (also: USDI)
DOT	Department of Transportation
DST	Deep Stratigraphic Test
EA	environmental assessment
EIS	environmental impact statement
ETWA	Eglin Water Test Area
F	Fahrenheit
FAA	Federal Aviation Administration

FCMA	Fishery Conservation and Management Act of 1976
FERC	Federal Energy Regulatory Commission
F.I.R.E.	finance, insurance, and real estate
FMP	Fishery Management Plan
FR	Federal Register
ft	foot
FWPCA	Federal Water Pollution Control Act
FWS	Fish and Wildlife Service
G&G	geological and geophysical
GLO	General Land Office (Texas)
GOM	Gulf of Mexico
GS	Geological Survey
H_2S	Hydrogen Sulfide
in	inch
IPF	impact producing factor
ITL	Information to Lessees
km	kilometer
kts	knots
LARI	Louisiana Artificial Reef Initiative
LCRP	Louisiana Coastal Resources Program
LOOP	Louisiana Offshore Oil Port, Inc.
LT	Long Ton
LTL	Letter to Lessees
m	meter
MCP	Mississippi Coastal Program
mi	mile
MIRG	Marine Industry Research Group
mm	millimeter
MMS	Minerals Management Service
MODU	mobile offshore drilling unit
MOU	Memorandum of Understanding
MPRSA	Marine Protection, Research, and Sanctuaries Act of 1972
NAAQS	National Ambient Air Quality Standards
NAS	National Academy of Sciences
NCP	National Contingency Plan
NEPA	National Environmental Policy Act
NERBC	New England River Basins Commission
NHPA	National Historic Preservation Act
NMFS	National Marine Fisheries Service
nmi	nautical mile
NOAA	National Oceanic and Atmospheric Administration
NOS	National Ocean Survey
NO_x	Nitrogen Oxides
NPDES	National Pollution and Discharge Elimination System
NPS	National Park Service
NRDC	Natural Resources Defense Council, Inc.
NRT	National Response Team
NTL	Notice to Lessees
NWR	National Wildlife Refuge
OCRM	Office of Ocean and Coastal Resource Management
OCS	Outer Continental Shelf
OCSLA	Outer Continental Shelf Lands Act
ORV	off-road vehicle
OSC	On-Scene Coordinator

OWOCRS	Open Water Oil Containment and Recovery System
O_x	Oxides
P.L.	Public Law
POE	Plan of Exploration
ppb	parts per billion
ppm	parts per million
PSD	Prevention of Significant Deterioration
psi	pounds per square inch
PWD	Parks and Wildlife Department (Texas)
PWSA	Ports and Waterways Safety Act
RCRA	Resource Conservation and Recovery Act
RD	Regional Director
REEFS	Recreational and Environmental Enhancement and Fishing in Seas
ROTAC	Regional Operations Technology Assessment Committee
RRT	Regional Response Team
RTWG	Regional Technical Working Group
SCUBA	Self-Contained Underwater Breathing Apparatus
SEA	Site-specific Environmental Assessment
SEL	Site Evaluation List
SIC	Standard Industrial Classification
SMA	Special Management Area
SMSA	Standard Metropolitan Statistical Area
SO_x	Sulphur oxides
tcf	trillion cubic feet
TDS	total dissolved solids
TOC	total organic carbon
TSP	total suspended particulates
TSS	traffic separation schemes
USAF	U.S. Air Force
U.S.C.	United States Code
USCG	U.S. Coast Guard
USDC	U.S. Department of Commerce
USDI	U.S. Department of the Interior (also: DOI)
USEPA	U.S. Environmental Protection Agency
USGS	U.S. Geological Survey
VOC	volatile organic compounds
WPA	Western Planning Area
yds	yards

I. DESCRIPTION OF THE PROPOSED ACTION

A. PURPOSE AND NEED OF THE PROPOSED ACTION

Description of the Proposed Action: The objective of the proposed action presented in this environmental assessment (EA) is to offer for lease 51 bidding units involving 153 of the 161 nominated tracts in the Central Planning Area (CPA) of the Gulf of Mexico (GOM) for exploration for and mining of elemental sulphur from salt dome cap rocks in an orderly, safe, and environmentally acceptable manner, in order to increase domestic sulphur production and thereby lower this Nation's dependence on foreign imports. Currently, the USA imports 17%-20% of its sulphur supplies, mostly from Canada and Mexico.

A Solicitor's Opinion (M-36548, January 19, 1959) states that salt is a valuable mineral which can be disposed of only in accordance with the law (Outer Continental Shelf Lands Act (OCSLA)) and concluded that the Department was not authorized to give a sulphur lessee free use of salt, even though it was needed to conduct sulphur mining operations. Thus, the rights to salt are being leased along with the sulphur rights; however, no salt is expected to be sold or brought onshore as a result of this action. The salt is solution-mined from a well (estimated one well per mine) drilled through the cap rock into salt from the bleedwater platform. The salt is brought to the surface as brine, which is treated, heated, and used in the Frash-process of sulphur mining as the mining fluid (see Appendix B). Of the brine pumped into the sulphur-bearing formation, 90% is pumped out as bleedwater. Thus, salt mined as a result of this proposed action will be used onsite in the sulphur mining process and will be discharged after its use as bleedwater. The nature of the bleedwater (salt) discharge is discussed in Section IV.A.3.a. and its impacts in Section IV.C.

Mineral leasing on the Outer Continental Shelf (OCS) is administered by the Department of the Interior (DOI) under the auspices of the OCSLA, as amended. The Act mandates the orderly development of OCS resources.

Pursuant to the National Environmental Policy Act of 1969 (NEPA), and the Council on Environmental Quality's (CEQ) regulations implementing NEPA, Minerals Management Service (MMS) decided to prepare this EA in order to determine if significant impacts would result from the proposed action. Information on which this decision was based was available from an EA prepared by MMS in 1986 for the reactivation of the offshore Caminada Sulphur Mine, and from the Grand Isle Sulphur Mine in production off Jefferson Parish, Louisiana (in state waters) since 1960.

The 153 tracts considered for lease in this EA, shown on the Sulphur/Salt Visual, all occur in water depths of less than 400 meters (m) and represent 724,798 acres. The offered bidding units are listed in Table I-1.

The archaeological resources, military areas, and operational constraints stipulations are offered in the proposal as additional mitigating measures for the proposed sulphur/salt lease sale and are addressed in the EA.

Need for the Proposed Action: The need for the proposal results from the mandate of the OCSLA which provides that the OCS shall be made available for mineral development. Specifically, this proposal would allow the sulphur production industry to explore and develop sulphur leases in a diligent manner and allow MMS to make reasoned decisions regarding several methods for developing resources on the OCS.

B. BACKGROUND OF THE PROPOSED ACTION

1. Administrative Events Leading to the Proposed Action

The first Gulf of Mexico offshore sulphur lease sale occurred in October 1954 off Louisiana. A total of 108 tracts were offered and 5 were bid on. The total of the high bids was $1,233,500. All 5 bids were accepted and the leases were subsequently relinquished. The next sulphur lease sale in the Gulf of Mexico occurred in December of 1965 offshore Texas. Of 648 tracts offered, 50 were bid on with high bids totalling $33,740,309. All were accepted and subsequently relinquished. The last sulphur lease offering in the Gulf of Mexico took place in 1969 when 38 tracts were bid on, 4 bids were accepted, and 34 were rejected. The price of sulphur began to fall and the offshore sulphur resource base was no longer economically attractive.

Since 1976 sulphur consumption in the United States has exceeded production and the price of sulphur has recently risen to the point where the sulphur-producing industry has expressed interest in expanding their OCS operations (Lore, 1986). MMS responded to this interest by publishing a *Federal Register* notice requesting comments on the desirability of conducting a Federal OCS sulphur lease sale in the GOM. Respondents were further

Table I-1

Bidding Units
Proposed Sulphur/Salt Lease Sale

Bidding Unit	Number of Tracts	Area	Blocks	Average Water Depth (meters)
1	1	WC, WA	306	16
2	3	WC, SA	521, 522, 544	56
3	2	EC	104, 115	20
4	2	EC	118, 119	21
5	1	EC	126	22
6	4	EC/WC	154, 155/263, 272	22
7	4	EC	178, 179, 184, 185	28
8	1	EC	229	36
9	4	EC, SA	293, 303, 304, 311	60
10	1	VR	124	22
11	2	VR	161, 162	27
12	2	VR	164, 179	28
13	4	VR	189, 190, 193, 194	32
14	4	VR	199, 200, 203, 204	32
15	4	VR	217, 218, 225, 226	34
16	2	SM/SM, NA	8/288	18
17	3	SM	33, 38, 39	28
18	6	SM/SM, SA	58, 69, 70/71, 72, 73	42
19	2	SM, SA	121, 132	61
20	4	EI	62, 63, 76, 77	6
21	5	EI	89, 94, 95, 110, 111	8
22	5	EI	116, 128, 128A, 129, 129A	16
23	4	EI	119, 120, 125, 126	12
24	4	EI	157, 158, 175, 176	25
25	2	EI	172, 184	24
26	4	EI	188, 189, 190, 191	22
27	3	EI	205, 218, 227	35
28	1	EI	208	28
29	4	EI	237, 238, 252, 253	43
30	4	SS	30, 31, 32, 33	5
31	2	SS	149, 154	17
32	4	SS	208, 209, 214, 215	30
33	5	SS/SS, SA	218, 219, 229, 230/242	40
34	4	SS, SA	268, 269, 274, 275	62
35	4	PL	11, 12, 19, 20	10
36	2	ST	63, 86	28
37	3	ST/GI, SA	131, 132/86	70
38	3	ST	134, 135, 151	40
39	4	ST	160, 161, 176, 177	40
40	1	GI	72	38
41	2	WD	30, 31	12
42	4	WD, SA	121, 122, 133, 134	86
43	3	WD, SA/MC	137, 138/267	150
44	3	WD, SA/MC	152/357, 358	160
45	4	SP, SE	88, 89, 93, 94	135
46	4	SP/SP, SE	60, 61/67, 70	90
47	1	MP	72	40
48	4	MP/MP, SE	144, 145/295, 296	65
49	1	MP, SE	289	105
50	1	MP, SE	299	64
51	2	MP, SE	305, 306	80

EC - East Cameron
EI - Eugene Island
GI - Grand Isle
MC - Mississippi Canyon
MP - Main Pass
NA - North Addition
PL - South Pelto
SA - South Addition
SE - South & East Addition
SM - South Marsh Island
SP - South Pass
SS - Ship Shoal
ST - South Timbalier
VR - Vermilion
WA - West Addition
WC - West Cameron
WD - West Delta

asked to provide information on production technology, stratigraphic test drilling, and possible leasing strategies in recognition of the fact that the economics and technology of sulphur production have greatly changed since the last OCS sulphur lease sale in 1969. Responses were received from seven private sector and governmental organizations. (See Section V.)

Based on the responses to the Request for Comments, MMS published a Call for Information and Nominations in the *Federal Register* on October 17, 1986, and a formal scoping process was begun. Meetings were held with various agencies, including the Regional Technical Working Group, members of the GOM Coastal States, other Federal agencies, and other interested parties, in order to establish the scope of the EA, to identify the significant issues which should be addressed in the EA, and to identify alternatives which should be considered.

On November 17, 1986, MMS mailed out requests for environmental information which would be pertinent specifically to sulphur leasing to selected individuals, agencies, and sulphur-related industries. No additional information was received.

Following a 45-day comment period, 161 tracts were nominated and additional comments were received in six responses. Three were from industry, one from a State government, one from an environmental organization, and one from another Federal agency. Based on the nominations and comments, the Assistant Secretary for Lands and Minerals of DOI, in December 1986, approved the Area Identification for the Proposed Sulphur/Salt Lease Sale. The Area Identification (AI) included 159 tracts representing some 754,798 acres in the CPA. Two of the nominated tracts were deleted from the AI due to their environmental sensitivity. Following subsequent analysis, the AI was further modified to defer two bidding units comprised of six tracts representing 30,000 acres due to environmental sensitivity.

2. Regulatory and Administrative Framework - Department of the Interior

a. Presale Activity

(1) Federal/State Coordination

The DOI has the responsibility to perform certain regulatory and administrative functions during the presale stage for sulphur leasing. The OCSLA requires DOI to coordinate with State and local governments prior to actual leasing when their states may be affected by offshore lease-related activity. Specific time frames are developed during which the Secretary provides information to the states and they, in turn, have opportunities to comment and coordinate with the Secretary.

Pursuant to procedures set forth under Section 7(a)(2) of the Endangered Species Act, an Endangered Species Consultation was held on January 13, 1987, and was attended by appropriate representatives of MMS, U.S. Fish and Wildlife Service (FWS), and National Marine Fisheries Service (NMFS). Further Federal coordination was conducted in accordance with DOI's Departmental Manual 655 on January 14, 1987. A meeting was held among MMS personnel, FWS, and NMFS to discuss the proposal. Issues identified and comments received from both meetings were incorporated into this EA.

Formal scoping was begun following the publication of the Call for Information and Nominations. Federal agencies, State and local governments, and other interested parties were requested to comment on the scope of the EA, significant issues which should be addressed, and alternatives which should be considered. Meetings were held with the Regional Technical Working Group (RTWG) members from the States of Texas, Louisiana, Alabama, and Florida. The State of Mississippi declined the opportunity to attend the meetings. Meetings were also held with several agencies in the State of Louisiana.

(2) Geological and Geophysical Activity Regulations/Coordination

Geological and geophysical (G&G) surveys and analyses provide most of the resource and hazards information used by government and industry on the sulphur potential of offshore areas. The collecting of G&G data begins prior to the leasing of Federal land and continues throughout the offshore mineral leasing program.

Pursuant to 30 CFR 251.4, permits must be obtained in order to conduct either geological or geophysical exploration for mineral resources or geological or geophysical scientific research of areas of the Gulf OCS. "Geological exploration for mineral resources" means any operation conducted on the OCS which utilizes geological and geochemical techniques, including, but not limited to, core and test drilling, well logging techniques, and various bottom sampling methods to produce information and data on mineral resources, including information and data in support of possible exploration and development activity. "Geophysical exploration for mineral resources" means any operation conducted on the OCS which utilizes geophysical techniques, including, but not limited to, gravity, magnetic, and various seismic methods to produce information and data in support of possible exploration and development activity. "Geological or geophysical scientific research" means any investigation conducted on the OCS using solid or liquid explosives, or drilling activities for scientific research purposes involving the gathering and analysis of geological or geophysical information and data which are made available to the public for inspection and reproduction at the earliest practicable time (30 CFR 251.2(n), (o), and (p)).

Permit applications for G&G activity must be submitted to MMS in accordance with requirements outlined in 30 CFR 251.5 and 30 CFR 251.6. The regulations under 30 CFR 251 do not apply to G&G exploration activities conducted by or on the behalf of the lessee on a leased block on the Gulf OCS. Geological and geophysical activities on existing leases are governed by the regulations in 30 CFR 250. The Gulf coastal states are not involved in the review process for specific G&G applications prior to issuance of the permit, except for Deep Stratigraphic Tests (DST's). Environmental reports are required in accordance with 30 CFR 251.6-2 for DST's, and, when required under a coastal zone management program, must receive State concurrence prior to approval of any activities covered under the permit. The plan and report would be made available to appropriate Federal agencies and the public in accordance with established practices and procedures.

After receiving the G&G permit application, MMS prepares either a categorical exclusion review (CER), EA, or environmental impact statement (EIS) in accordance with applicable MMS policies and guidelines, as described in Section I.B.2.b.(1). A CER is prepared for most G&G permit applications. Exceptions to the categorical exclusion process, automatically requiring the preparation of an EA, are those activities which include the drilling of DST's, involve the use of solid or liquid explosives, or which otherwise have the potential to significantly affect the quality of the human environment.

b. Postsale Activity Regulation/Coordination

(1) Review, Coordination, and Approval of Exploration, Development and Production Activities

MMS is responsible for regulating and monitoring sulphur operations on the Federal OCS. The regulations at 30 CFR 250.11 provide for the Director to regulate all operations conducted under a lease or permit and to issue or amend OCS Orders and other rules as may be necessary to supervise operations and, to prevent harm or damage to, or waste of any natural resource, life, property, or the marine, coastal, or human environment. Prior to either exploration, development, or production activities being conducted in a leased block, companies must submit plans to MMS for review and approval. Within these plans, specific requirements must be met relative to operating conditions and environmental considerations. The MMS is currently preparing a draft Subpart P, Sulphur and Salt Operations, which is to be appended to the proposed 30 CFR 250 regulations. Information collected pursuant to this subpart would provide the MMS with data concerning the exploration, drilling, production, storage, measurement, transportation, operational safety, and environmental protection concerning OCS operations on sulphur and salt leases.

The review, coordination, and approval of sulphur exploration, development, and production activities by MMS would be procedurally the same as for oil and gas operations. Pursuant to Section 11 of the OCSLA and 30 CFR 250.34-1 and 3, an exploration plan and environmental data (e.g., Environmental Report (ER), archaeological data, live bottom survey/report, and/or biological monitoring plan, if required) must be submitted for approval to MMS before an operator may begin exploratory drilling on a lease. MMS prepares a Categorical Exclusion Review (CER), EA, or EIS based on all available information which may include the submitted plan, ER, archaeological reports, air emissions data, live bottom survey/report, biological monitoring plan, previous environmental documents and comments, and recommendations by the affected State(s), the Department of Defense, the FWS (for selected plans under provisions of DM 655), the NMFS, and/or internal MMS offices. MMS evaluates the proposed activity for potential impacts relative to geohazards and man-made hazards (including existing pipelines), archaeological resources, endangered species, sensitive biological features, water and air quality, and other uses (e.g., military or oil and gas operations) of the OCS. An Application for Permit to Drill (APD) is filed by the lessee/operator along with or subsequent to submission of the Exploration Plan and supporting information. The APD requires detailed information about the drilling program for evaluation with respect to operational safety and pollution prevention measures. Other permits required prior to exploratory drilling include permits for aids to navigation from the U.S. Coast Guard (USCG), permits for installation of structures attached to the seabed from the U.S. Army Corps of Engineers (COE), and National Pollutant Discharge Elimination System (NPDES) permits from U.S. Environmental Protection Agency (USEPA) if the plan is not covered under the Gulf of Mexico general NPDES permit.

Development and production plans are not required for leases in the Western Gulf pursuant to 30 CFR 250.34-2(a)(2), effective January 13, 1984. (In this designation, the Western Gulf includes all areas of the Gulf of Mexico except those that are adjacent to the State of Florida.) However, information covering these leases is required to ensure confirmation with the OCSLA, other laws, applicable regulations, and lease provisions and to enable MMS to carry out its functions and responsibilities. Therefore, prior to any development and production activity being conducted on a lease in the Western Gulf, the operator must prepare and submit to MMS a Development Operations Coordination Document (DOCD), and, if required, an environmental report, archaeological report, or biological report (monitoring and/or live bottom survey), etc., or other environmental data determined necessary. After receiving the Plan of Development/Production or DOCD, MMS prepares either a CER, EA, or EIS. After the approval of the plan, the operator submits to MMS specific applications, such as those for lease-term pipelines and platforms, to conduct activities described in the plan. Additional applications submitted for approval to various Federal agencies include those to the USCG for aids to navigation, COE for navigation and platform installation permits, and USEPA for NPDES permits of the plan is not covered under the Gulf of Mexico general NPDES permit.

Operational procedures and requirements for OCS pipelines, as stipulated in the Pipeline Procedures Handbook (OCS Report/MMS 84-0015), are different for two major categories of lines, i.e., lease term and rights-of-way lines (USDI, MMS, 1984b). Rights-of-way lines, for which annual right-of-way fees are paid, are not wholly contained within the boundaries of a single lease, unitized leases, or contiguous leases of the same owner or operator and are regulated under 30 CFR 256 Subpart N. Lease-term lines, for which no annual rental fees are charged, are wholly contained within the boundaries of a single lease, unitized leases, or contiguous leases of the same owner or operator and are regulated under 30 CFRl 256 Subpart N. Lease-term lines, for which no annual rental fees are charged, are wholly contained within the boundaries of a single lease, unitized leases, or contiguous leases of the same owner or operator and are regulated under 30 CFR 250.20.

Post-sale activity regulation procedures are discussed in more detail in Section I.B.3.b.(1)(a) of final EIS 110/112. A site-specific environmental assessment document (SEA No. U-402, dated July 30, 1985), based on plan information, was prepared in accordance with these procedures and is available from the Gulf of Mexico OCS Region's Public Information Unit. This proposal resulted in permit approval of development/production sulphur activities at the Caminada Sulphur Mine, Grand Isle Blocks 16, 17, 22, and 23, Leases OCS 024, 025, 031, and 034, respectively. Sulphur drilling procedures are currently covered by OCS Order No. 10 (effective August 28, 1969) in accordance with 30 CFR 250.34, 250.41, and 250.91. Development wells are drilled in accordance with field rules established by each District Supervisor. All pertinent requirements imposed on oil and gas drilling will also be imposed on sulphur drilling by the District Supervisor, where applicable, in order to assure the same level of protection to human health and the environment.

(2) Regulatory Enforcement Measures

(a) Inspections

Drilling and production compliance inspections are conducted before, during, and after operations to assure compliance with lease terms, Notices to Lessees (NTL's), and approved plans and to assure that safety and pollution-prevention requirements of regulations and OCS Orders are met. These inspections also involve items of environmental concern. Noncompliance with checklisted requirements for specific installations or procedures are followed by prescribed enforcement actions, consisting of written warnings or shut-ins of platforms, zones (well), equipment, or pipelines. In some cases, more than one enforcement action is noted. The MMS inspector then determines the appropriate enforcement action based on an assessment of the risk of either pollution or accident, the history of the lessee, the stage of operation in progress, and the status of other systems. The primary objective of initial inspections is to assure proper installation of mobile units or structures and associated equipment. After operations begin, additional unannounced inspections are held. Depending on the distance from shore, MMS district personnel will visit and inspect from one to three different rigs or platforms per day. Aerial surveillance of additional offshore structures is conducted enroute.

(b) Special Inspection Procedures

The drilling of sulphur wells utilizes essentially identical technology to oil and gas drilling, with the exception of completions. The operator will normally request the use of oil-based muds at the Application for Permit to Drill stage if problems are anticipated or during drilling if problems are encountered. Approval is granted with the understanding that the cuttings will be treated (chemically) and washed prior to dumping or they will be collected and transported to shore for disposal. The latter method is used when only a small "plug" is needed to solve a problem (stuck drill pipe, etc.) or when the rig does not have the equipment to properly treat the mud.

Inspections are usually conducted for all rigs and platforms every 10-14 days, weather permitting. Inspectors try to visit operations using oil-based muds more often, or at least make an effort to "fly-by" when in the area.

Of initial importance to inspectors is the presence or absence of a "visible sheen" in the waters adjacent to a rig using oil-based muds. On-board inspection involves seeing that the muds and cuttings are being properly treated and/or disposed of. The "bucket test" involves dropping 2-3 handfuls of cuttings into a bucket of seawater to test for residual oil. The presence or absence of a "visible sheen" in the bucket determines whether or not the cuttings are being properly treated prior to being dumped.

District personnel inspect H_2S sensors to make sure that they are operational, inspect logs for timely calibration of instruments, and ensure that rig personnel have been trained in appropriate equipment handling, safety regulations, and emergency procedures.

(c) Suspension of Operations and Cancellation of Leases

Section 5(a) of the OCSLA and regulations appearing in 30 CFR 250.12 provide for the suspension or temporary prohibition of an operation or activity:

(1) when the lessee fails to comply with the appropriate laws, regulations, or orders;

(2) when there is a threat of immediate harm or serious irreparable damage to life (including aquatic life), property, mineral deposits, or environment;

(3) when in the interest of national security or defense;

(4) for any purpose necessary for the implementation of NEPA; and

(5) at the request of the lessee if the Director determines that the request is in the national interest and will (a) facilitate proper development of the lease, (b) allow for construction or negotiation for the use of transportation facilities, or (c) facilitate installation of equipment determined necessary by the Director.

The Secretary may cancel a lease or permit if, after a hearing, he determines: (1) that continued activity would probably cause serious harm or damage to life, to property, the environment, or national security or defense; (2) that the threat of harm or damage will not disappear or decrease to an acceptable extent within a reasonable time; and (3) the advantages of cancellation outweigh the advantages of continued activity. A lease may be canceled only following suspension or temporary prohibition on a lease or permit continuously for a period of five years (or for a lesser period at the request of the lessee).

(d) Remedies and Penalties

Under Section 24 of the OCSLA and regulations appearing at 30 CFR 250.80, both civil and criminal penalties can be assessed for failure to comply with responsibilities under the law, a license, a permit, or any regulation or order issued pursuant to the Act. Further, under Section 5 of the OCSLA, the issuance and continuance in effect of any lease or of any assignment or other transfer of any lease shall be conditioned upon compliance with regulations issued under the OCSLA.

(3) Environmental Safeguards

(a) Notice to Lessees and Operators (NTL) 83-3 Concerning Shallow Hazards for the Gulf of Mexico OCS Region

NTL 83-3 specifies the requirements to ensure that all exploratory, development, and production operations are conducted with a minimum risk to human life and the environment. NTL 83-3 applies to all existing and future leases and pipeline rights-of-way in the Gulf of Mexico, including sulphur operations and will be applied through the approval process for plans of exploration, development, or production. Prior to any seafloor disturbing activities at proposed drilling sites, platform sites or pipeline routes, a lessee or operator must assess any seafloor and subsurface geologic or man-made features and conditions which may have an adverse effect on the proposed operations. Seafloor geologic hazards include fault scarps, gas vents, unstable slopes, and reefs. Subsurface geologic hazards include faults, gas-charged sediments, abnormal pressure zones, and buried channels. Man-made hazards include pipelines, wellheads, shipwrecks, ordnances, communication cables, and debris from previous oil and gas activities.

NTL 83-3 consists of two basic parts: survey requirements and shallow hazards report.

Survey Requirements: The NTL requires geophysical instrumentation which is state-of-the-art in technological development, and all data recorders must be keyed to the navigation system to assure proper integration of information. Required geophysical instrumentation includes: (a) a total field intensity magnetometer to determine the presence of pipelines and other ferromagnetic objects; (b) a dual-channel side scan sonar to record continuous planimetric images of the seafloor; (c) a shallow, penetration subbottom profiler to determine the character of near-surface geological features; (d) a medium, penetration seismic profiler capable of penetrating at least 300 m (980 ft) to determine the character of deeper geological features; (e) a high-frequency, narrow-beam depth sounder to provide continuous water depth measurements; and (f) additional instrumentation such as underwater television, still or movie cameras, divers, coring, remote or manned submersibles, and additional geophysical survey lines that may be necessary under certain conditions. Survey parameters are also explicitly detailed.

Shallow Hazards Report: An evaluation of data gathered during the shallow hazards survey and a synthesis with other available geological and geophysical information is required. Reports must contain a description of the area (lease number, block number(s), OCS area(s), and water depth); a listing of individuals involved in the survey and report and a brief description of the duties of each; a discussion of the survey including navigation, instrumentation, and parameters (i.e., scale and sensitivity settings and tow depths); a description of the survey vessel and sensor configuration; sea and weather conditions; and map(s) at a scale of 1:12,000 depicting navigation postplot, bathymetry, shallow geologic structures, deep geologic structures, and any anomalies detected by the instrumentation. The report also must include an assessment of the potential for shallow hazards within the survey area and a summary of conclusions and recommendations supported by the survey data and analyses. The report must be signed by a geologist or geophysicist specializing in high-resolution geophysical interpretation.

MMS reviews the shallow hazards survey and report, and if a potential hazard is identified within the area of proposed operations, the operator has three alternatives:

(1) relocate the proposed site of operations to avoid the potential shallow hazard;

(2) demonstrate to the Regional Supervisor, Offshore Rules and Production, that the use of special protective measures will minimize the risk to safe operations; or

(3) establish by further investigations deemed necessary by the Regional Supervisor that such operations will not be adversely affected by the shallow hazards.

(b) OCS Orders

OCS Orders are administered by MMS and deal specifically with technical matters or problems of a particular geographical area. They supplement regulations governing drilling and production operations on the OCS as listed in 30 CFR 250. Of the 14 Gulf of Mexico OCS Orders, one (OCS Order No. 10) is specific to sulphur drilling procedures. Other OCS orders are currently being reviewed by MMS to determine their applicability to sulphur operations.

OCS Order No. 10 provides requirements for all exploratory core holes and all sulphur development wells, including setting depths and cementing requirements for drive or structural casings, conductor casings, and cap rock casings. Requirements are also included for blowout preventers; related well control equipment; testing; and mud control, mud testing, and equipment.

(c) Lease Stipulations

Exploration and development activities on the OCS have the potential for causing adverse environmental impacts; therefore, stipulations are developed prior to the sale (discussed under Sections II and IV in this document) and are attached to the lease instrument, as necessary, in the form of additional mitigating measures. Archaeological resource and military areas stipulations are those which have been attached most often to the leases in previous Central and Western Gulf lease sales. An operational constraints stipulation has been considered and proposed a part of this proposed sale. MMS is responsible for ensuring full compliance with stipulations appended to leases.

(d) Air Quality

Section 5(a)(8) of the OCSLA provides that the Secretary shall promulgate and administer regulations to provide for compliance with the National Ambient Air Quality Standards (NAAQS) pursuant to the Clean Air Act. This has been accomplished through 30 CFR 250.57 and administered by MMS as a postsale activity. It is the intent of 30 CFR 250.57 to protect onshore ambient air quality and to ensure that no new violations of the NAAQS are caused by the OCS activity. The criteria pollutants which are regulated are carbon monoxide, total suspended particulates, sulphur dioxide, nitrogen oxides, and volatile organic compounds. Emissions from new or modified onshore facilities directly associated with offshore activities are required to enable each affected state to make a determination of the effects on their air quality.

Plans of exploration, plans of development and production (which include some pipelines), and DOCD's have been determined by the Secretary as activities regulated under 30 CFR 250.57. These regulations provide for the following:

- All new or revised exploration, development and production plans, and DOCD's submitted on or after June 2, 1980, shall include air emissions information sufficient to make an air quality determination.

- A review is made relative to each plan submitted and the levels of expected emissions, as opposed to the exemption formulas, are outlined. There are provisions for required controls for those facilities found nonexempt by the aforementioned formulas.

- If MMS or an affected state submits information which demonstrates that emissions from an otherwise exempt facility will significantly affect any onshore area, additional information is collected and reviewed for that facility.

(e) Best Available and Safest Technology

To assure that exploration, development, and production activities on the OCS are conducted in a safe and pollution-free manner, Section 21(b) of the OCSLA, as amended, requires that all OCS technologies and operations use the best available and safest technology (BAST) which the Secretary determines to be economically feasible. Conformance to the standards, codes, and practices referenced in OCS Order Nos. 2, 5, 7, 8, and 10 is considered to be the application of BAST. These orders include requirements for state-of-the-art drilling technology, production safety systems, completion of sulphur wells, oil spill contingency plans, pollution control equipment, and specifications for platform/structure designs. All applicable requirements which are currently imposed on oil and gas operations will be imposed on sulphur operations during the permitting stage, even though the wording in the OCS orders may apply specifically to oil and gas. This will be done to assure the same level of safety in sulphur operations as currently exists for oil and gas operations. MMS conducts periodic offshore inspections, and the Rules, Orders, and Standards section continuously and systematically reviews OCS technologies to insure that the best available and safest technologies are applied to OCS operations. BAST is not required when the Secretary determines that the incremental benefits are clearly insufficient to justify increased costs; likewise, it is the responsibility of an operator on an existing operation to demonstrate why application of a new technology would not be feasible. This requirement is applicable to equipment which, if it failed, would have a significant effect on safety, health, or the environment, unless benefits clearly do not justify the cost.

The BAST concept is addressed in the Gulf of Mexico OCS Region by a continuous effort to locate and evaluate the latest technologies and to report on these advances at periodic Regional Operations Technology Assessment Committee (ROTAC) Meetings. A portion of the MMS staff has an ongoing function to evaluate various vendors and industry representatives' innovations and improvements in techniques, tools, equipment, procedures, and technologies applicable to all drilling, producing, and completion operations. This information is provided to MMS district personnel at ROTAC meetings. The requirement for the use of BAST has, for the most part, been an evolutionary process whereby advances in equipment, technologies, and procedures have been subtly integrated into OCS operations over a period of time. An awareness by both MMS inspectors and the OCS operators of the most advanced equipment and technologies has resulted in the incorporation of these advances into day-to-day operations.

(f) Pipelines

Regulations contained under 30 CFR 256 Subpart N provide procedures for the granting of and administration of rights-of-way for the transportation of minerals by pipeline through the OCS. Additional regulations may be imposed on rights-of-way grants issued by MMS for pipelines and accessory structures. OCS Order No. 9 further regulates and requires that all pipelines shall be installed and maintained to be compatible with trawling and other operations. Locations of pipelines and platforms are shown on maps produced by MMS, the National Ocean Survey (NOS), and the U.S. Geological Survey (USGS). FWS also reviews applications for operations and proposed pipeline rights-of-way that may impact biologically sensitive areas as well as those applications that indicate a crossing of coastal land and water areas. Procedures for reporting pipeline damage are discussed in detail in NTL 80-9. For additional information, see Volume 1, Sections I.B.3.b.(6) and (7) of the Final Regional EIS.

(g) Other Environmental Safety Controls

Besides its regulations, OCS Orders, and lease stipulations, MMS has two mechanisms which may be utilized to control or mitigate environmental or safety problems which may arise. NTL's may be issued which define operational problems and necessary actions for solution. NTL 83-3 (Section I.B.2.b.(3)(a)) provides for survey and hazard report requirements to allow safer operations, and NTL 86-11 concerns trash and debris. In addition, conditions which may be necessary to provide environmental protection may be applied to any permit, right-of-use, or easement.

Notice to Lessees and Operators 86-11 Concerning Trash and Debris for the Gulf of Mexico OCS Region

Although wording in NTL 86-11 mentions only oil and gas operations, MMS proposes to apply this NTL to sulphur operations during the permit approval stage in order to afford the same level of environmental protection that is afforded from oil and gas operations.

NTL 86-11 provide guidelines for reducing or eliminating trash and debris in the Gulf of Mexico. The text dated November 17, 1986, reads as follows:

> Lessees are advised that oil and gas operations in the Gulf of Mexico may be contributing to a chronic problem of marine debris which comes ashore and detracts from the aesthetic quality of recreational shorefronts and increases the cost of park and beach maintenance. Subparagraph 1.2.2 of OCS Order No. 7 prohibits the deliberate discharge of containers and other similar solid waste materials (i.e., trash and debris) in the marine environment, and paragraph 5 of OCS Order No. 1 requires durable operator identification markings on equipment, tools, and containers (especially drums) and other material weighing more than 40 pounds.

Special caution should be exercised in handling and disposing of small items and packaging materials, particularly those made of nonbiodegradable, environmentally persistent materials such as plastic or glass, which may be lost in the marine environment and washed ashore. Increasing the individual worker's awareness of the problem and his responsibility to help curtail it will do much to reduce the litter problem.

The Minerals Management Service (MMS) acknowledges and appreciates the steps being taken by industry. The Offshore Operators Committee has prepared a videotape on beach litter which strongly encourages its members to use in training and safety programs. Several companies plan to run the film and present additional information on beach litter at their monthly safety meetings.

The MMS recommends that all operators on the OCS develop training aids and conduct periodic training and awareness sessions targeted at all offshore workers (contractors and subcontractors, especially boat operators, seismic and geophysical crews, drilling and production crews, derrick barge crews, and pipeline barge crews) which will emphasize the proper control and disposal of offshore refuse.

Additionally, MMS recommends the following: (1) that all OCS users adopt trash reduction methods, including compaction, and packaging for all materials sent to onshore disposal sites and (2) that industry implement a control system to account for the proper disposal of trash, particularly drums and hazardous items

This NTL is effective immediately and will remain in effect until cancelled or superseded.

(4) Regional Technical Working Group

In 1979, DOI established the Outer Continental Shelf Advisory Board following the requirements of the Federal Advisory Committee Act (5 U.S.C. Appendix I). The purpose of the Board, as set out in the charter, is to provide advice to the Secretary of the Interior, the Director, and other officers of MMS in the performance of discretionary functions of the OCSLA, as amended.

The Board is made up of three elements: the Policy Committee, the Scientific Committee, and six RTWGs. The Policy Committee advises the Secretary concerning discretionary functions, including all aspects of OCS exploration and development. The function of the Scientific Committee is to advise the Director on the feasibility, appropriateness, and scientific value of the Environmental Studies Program. The RTWG advises the Director on technical matters of regional concern relating to offshore minerals management.

The Gulf of Mexico RTWG is composed of State and Federal representatives, industry specialists, environmental interests, and people with special interests in the OCS. The purpose and objectives of the RTWG is to convene these various representatives of interests that may be affected by MMS's minerals leasing program, to provide a flow of information between the parties, and to advise the Director on technical matters of regional concern regarding the presale and postsale activities. The Gulf committee is primarily involved in reviewing and commenting on technical aspects of various sale activities and related documents and in reviewing proposals and plans for conducting environmental studies. In addition, the group participated in the first edition of a regional transportation plan for pipelines in 1981.

The information sought by MMS through the RTWG is primarily for use in developing scenarios, alternatives, and raising issues in EIS's, as well as recommending specific regional environmental studies. Potential difficulties can often be resolved early in the sale process. The opportunity exists for discussions and exchanges of technical information.

The Gulf of Mexico RTWG held its first meeting in October 1979, has been actively involved in carrying out various program objectives.

3. Other Federal Agency Regulatory/Administrative Measures

a. Navigation

Responsibilities for regulating navigation on the OCS are shared by USCG, the Federal Aviation Administration (FAA), COE, and MMS. A detailed description of these responsibilities may be found in Section I.B.4.a. of Final

EIS 81/84. The Ports and Waterways Safety Act (PWSA) (33 U.S.C. 1221) provides for necessary fairways and traffic separation schemes for vessels operating offshore and recognizes, with some limitations within fairways, the paramount right of navigation over all other uses. The PWSA requires that the USCG consult with DOI to reconcile the need for safe access routes with the needs of all other reasonable uses of the area involved. Responsibility for permitting mobile drilling units (MODU's), fixed structures, and pipelines are covered by the nationwide COE permit program provision (33 CFR 330.5(a)(8)). On October 5, 1984, COE published the final rule on "Regulations for Controlling Certain Activities in Waters of the U.S." in the *Federal Register* (49 FR 39478). The major affect of the new rule is to establish reporting requirements and procedures.

The lease blocks and parts of blocks that lie within fairways are subject to certain constraints. Although sulphur resources can be exploited through directional drilling, no structure may be placed in a fairway. These constraints also apply to the safety zone, fairways, and anchorage of the Louisiana Offshore Oil Port (LOOP). Lessees are advised that the U.S. Coast Guard (USCG) map designate necessary fairways through leased blocks in accordance with the Ports and Waterways Safety Act. Three tracts in the proposed sale occur in safety fairways in the Central Gulf of Mexico. They are West Cameron, West Addition Block 306, Mississippi Canyon Block 350, and South Pass, East Addition Block 70 (see Visual No. 3 and Sulphur/Salt Sale Visual).

b. OCS Pipelines

Regulatory processes and jurisdictional limitations concerning pipelines on the OCS and in coastal areas are shared by several Federal agencies (DOI, Department of Transportation (DOT), FERC, COE, and USCG) as shown in Volume 1, Section I.B.4.b. of the Final Regional EIS. The regulations are contained in 49 CFR 191-193 and 195.

There is a Memorandum of Understanding (MOU) between the DOT and DOI which gives recognition to each party's respective regulatory responsibilities. Basically, DOT is responsible for establishing and enforcing design, construction, operation, and maintenance regulations for pipelines extending to the shore from the outlet flange of an offshore facility. DOI responsibility extends upstream from the outlet flange.

c. Coastal Zone Management

Seven of the nine largest metropolitan areas in the United States exist within the coastal zone, and more than 50% of the population lives within 50 miles of the coastline. This has caused a diversity of increasing multiple use pressures, such as recreation, plant sitings, community development and services, and expansion of port and marine facilities. As a result of the interface between coastal resources and land use conflicts, the Coastal Zone Management Act (CZMA) (16 U.S.C. 1451-1464) was enacted. The Act is administered by the Office of Ocean and Coastal Resource Management (OCRM) which was formerly named the Office of Coastal Zone Management and which is under National Ocean Service of the National Oceanic and Atmospheric Administration (NOAA) within the Department of Commerce (DOC). The CZMA sets major goals for the protection of natural, historic, and archaeological resources, and it provides for increased recreational access, the management of coastal development, and the coordination and streamlining of Federal and State decisions directly affecting the coastal resources. A Federal action directly affecting the coastal zone must be consistent with an affected coastal state's federally approved coastal management plan. If a serious consistency disagreement arises, mediation can be undertaken with the Secretary of Commerce.

The Act also provides Congress the opportunity to provide aid to the states in the form of grants. Section 305 authorizes grants for development of management programs for land and water resources in the coastal zone. Section 306 authorizes grants of not more than 80% of the program's administrative costs. Section 307 deals with interagency coordination and cooperation. A more detailed discussion of these CZMA sections has been given in Section I.B.4.c. of Final EIS 81/84.

d. Archaeological Resources Legislation

The Federal Government's involvement in archaeological resource management and protection on the OCS is based on the requirements of the National Historic Preservation Act of 1966, as amended, which states, in effect, that any Federal agency, prior to approving Federally permitted or Federally funded undertakings, must take into consideration the effect of that undertaking on any property listed on, or eligible for, the National Register of

Historic Places. Implied in this legislation and Executive Order 11593 is that an effort be made to locate such sites prior to development of an area. Section 11(g)(3) of the OCSLA, as amended, states that "such exploration will not . . . disturb any site, structure, or object of historical or archaeological significance."

e. Endangered Species Act of 1973

The Endangered Species Act of 1973 (16 U.S.C. 1531-1543, 50 CFR 17), as amended, is administered by FWS and the NMFS, and it establishes a national policy designed to protect and conserve endangered and threatened species and the ecosystem upon which they depend. Section 7 of the Act, governing interagency cooperation, provides for Federal agencies to consult with FWS and NMFS to ensure that their actions do not jeopardize the continued existence of an endangered or threatened species and/or result in adverse modification or destruction of their critical habitat.

f. Marine Mammal Protection Act of 1972

The Marine Mammal Protection Act of 1972 [16 U.S.C. 1361-1407, 86 Stat. 1027 (1972), 95 Stat. 979 (1981)], as amended, establishes a national policy designed to protect and conserve marine mammals and their habitats. Authority for administering the Act has been delegated to the NMFS, which is responsible for all cetaceans and pinnipeds (except walrus), and FWS, which is responsible for walrus, sea otters, manatees, and dugongs. The Act specifically prohibits the harassing, hunting, capturing, or killing of any marine mammal unless otherwise exempted under provisions of the Act. The Marine Mammal Commission is responsible for advising Federal agencies on the protection and conservation of marine mammals. The Commission has a Committee of Scientific Advisors which provides advice on actions needed to fulfill the purposes of the Act.

g. Fishery Conservation and Management Act of 1976

The Fishery Conservation and Management Act of 1976 (FCMA) (16 U.S.C. 1801-1882) established a fisheries conservation zone off the coasts of the United States and its possessions from the states' seaward boundary to a line that is 200 nmi from the baseline from which the territorial sea is measured. The Act created eight Regional Fisheries Management Councils and mandated a continuing planning program by the Councils. As a part of this program, a Fishery Management Plan (FMP) must be prepared for each species (or related group of species) of fish harvested within each respective region.

The Act, as amended, requires that a FMP based upon the best available scientific and economic data be prepared for only those species (or related group of species) of fish harvested within each respective region that is in need of conservation and management.

The FMP for shrimp was implemented in May 1981; the FMP for stone crab was implemented in March 1982; the FMP for spiny lobster was implemented in April 1982; the FMP for coastal pelagics was implemented in February 1983; the FMP for coral was implemented in August 1984; the FMP for reef fish was implemented in November 1984; and the FMP for swordfish was implemented in September 1985.

For a more detailed description of the Fishery Conservation and Management Act of 1976, see Volume 1, Section I.B.4.g. of the Final Regional EIS.

h. National Fishing Enhancement Act of 1984

Title II of Public Law 98-623, also known as the Artificial Reef Act, establishes a National policy of the United States to encourage the development of artificial reefs which will enhance fishery resources and commercial and recreational fishing. The Secretary of Commerce is directed to take the lead in developing National standards and a National Artificial Reef Plan that identifies design, construction, siting, and maintenance criteria for artificial reefs, and to provide a synopsis of existing information and future research needs on artificial reefs. The Secretary of the Army will issue permits to responsible applicants for reef development projects in accordance with the National standards and plan, as well as regional and local criteria and plans. The new law also limits liability of reef developers complying with permit requirements and amends the Reefs for Marine Life Conservation Law to include the availability of all surplus Federal ships for consideration as reef development materials. Although the Act mentions no specific materials other than ships for use in reef development projects, the Secretary of the Interior is required to cooperate with the Secretary of Commerce in developing the National plan. The Secretary of the Interior has already taken several initiatives in support of this National policy by creating the Recreational and Environmental Enhancement and Fishing in Seas (REEFS) task force and is cooperating with ocean industries through MMS in developing a Rigs-to-Reefs policy and program.

i. Executive Order 11990, Protection of Wetlands

Executive Order 11990, Protection of Wetlands (May 24, 1977), is pertinent to the proposed action as it states in part:

> "Each agency shall provide leadership and shall take action to minimize the destruction, loss or degradation of wetlands, and to preserve and enhance the natural and beneficial values of wetlands in carrying out the agency's responsibilities for . . . conducting Federal activities and programs affecting land use, including but not limited to water and related land resources planning, regulating and licensing activities. This Order does not apply to the issuance by Federal agencies of permits, licenses, or allocations to private parties for activities involving wetlands on non-Federal property."

This Order would apply to two National Parks and two National Wildlife Refuges in the Central Gulf region.

j. Ports and Waterways Safety Act

The Ports and Waterways Safety Act authorizes the Coast Guard to designate necessary fairways and traffic separation schemes (TSS) to allow vessels unobstructed, safe access to U.S. ports. Safety fairways are areas in which no fixed structures are permitted, and therefore may inhibit exploration and exploitation of mineral resources in the area so designated. Fairways may be viewed as a necessary compromise between convenient mineral exploitation and concern for navigation safety. TSS's are designed to increase navigation safety by separating opposing lanes of vessel traffic. In order to ensure that the interest of all affected parties are considered, the Act mandates that a port access route study be conducted when new fairway areas of TSS's are contemplated. Publication of a study notice advises all bidders in future lease sales within the study area that occupancy rights may be restricted by a routing system developed as a result of the study.

4. Regulations Governing Discharges

The Federal Water Pollution Control Act of 1972 (33 U.S.C. 1251 et seq.) (FWPCA), as amended, and commonly called the Clean Water Act, provides a major tool to the Federal Government to ensure that the chemical, physical, and biological integrity of the Nation's waters are maintained. It provides a comprehensive plan for dealing with oil spills and discharges of oil and oil-containing substances into Gulf waters in connection with activities under the OCSLA, as amended. The FWPCA addresses prevention and control of spills, response to and removal of spilled oil, and for the determination of liability and compensation for damage resulting from spills. These aspects of the FWPCA are discussed in Volume 1, Sections I.B.5.a.(1), b., and c.(1) and (2) of the Final Regional EIS.

Other important acts under which regulations have been promulgated to minimize pollution incidents and the potential environmental and economic damage caused by the release of pollutants from various sources to Gulf waters include the OCSLA, as amended, the Ports and Waterways Safety Act, and the Comprehensive Environmental Compensation and Liability Act (CERCLA), or "Superfund." Other acts which exert a lesser influence due to their restricted applicability in the Gulf include the Deep Water Port Act of 1974 and the Trans-Alaskan Pipeline Authorization Act. The Clean Air Act provides for regulations controlling air emissions from shorebased OCS-related facilities. The legal mandates and regulations relative to pollution control established by these Federal statutes, along with the administering Federal departments and agencies, are detailed in the Final Regional EIS.

Those acts and regulations which are general in nature and will cover sulphur operations are briefly described below. More detail and other acts or regulations are discussed in detail in Volume 1, Sections I.B.5.a.(1), I.B.5.b., I.B.5.c.(1), and I.B.5.c.(2) of the Final Regional EIS.

National Pollution Discharge Elimination System (NPDES)

The USEPA Regions IV and VI, which have regulatory authority in the Gulf of Mexico, have issued the final NPDES general permit. This permit established effluent limitations, prohibitations, reporting requirements, and other conditions on discharges from offshore facilities conducting exploration, development, and/or production operations in the Gulf of Mexico. The final rule was published in the *Federal Register* on July 9, 1986 (51 FR 24897) and went into effect July 2, 1986. This permit replaces General Permit No. TX0085642 which was published in the *Federal Register* on April 3, 1981 (46 FR 20284) and reissued on September 15, 1983 (48 FR 41494).

The General NPDES Permit issued by the USEPA for oil and gas operational discharges in the Gulf will not apply for sulphur mining discharges. Upon application to the USEPA by the sulphur lessee, an individual permit will be considered and issued with permit conditions appropriate for that specific lease. For oil and gas operations, the General Permit relies on MMS for determination of biologically sensitive areas, and does not impose a limit on the discharge rate of drilling fluids near such areas by the oil and gas lessee if shunting of the fluids is required by an MMS lease stipulation. If the shunting stipulation is not imposed by MMS, the General Permit requires a discharge rate limitation. MMS funded studies, as well as stipulation-required monitoring studies, have demonstrated that the shunting of drilling fluids to within 10 m of the bottom does indeed protect the biota of nearby topographic features from the potential harmful effects of the fluids; the effectiveness of the discharge rate limitation for a non-shunted discharge is speculative since no studies have been conducted on this technique.

Consultation with USEPA representatives indicate that they can make no judgment on permit conditions for sulphur operations until an application is received. If discharge of drilling fluids in an area where an existing oil and gas lease would have a shunting requirement imposed by lease stipulation does not have such a stipulation for sulphur operations, USEPA could require the development of an entirely new dispersion model to evaluate restrictions, or they could require their existing discharge rate limitation, or they could even require shunting, or they could take some other approach that has not been promulgated. Since no blocks offered in this proposal would have a biological stipulation if offered in an oil and gas sale, it is assumed that USEPA will have no additional restrictions on the discharge of drilling fluids from sulphur operations. Special conditions, however, such as monitoring, may be imposed on bleedwater discharges.

Department of Transportation's Prevention Program

The U.S. Coast Guard has the responsibility for pollution prevention of the Nation's navigable waters. When this prevention proves impossible, they bear the responsibility of identifying, controlling, and cleaning up the oil or other contaminants which pollute United States' waters, except when MMS's authority over OCS oil and gas exploration activities supersedes their authority.

Section 4 of the OCSLA grants authority to USCG to promulgate and enforce regulations covering lighting and warning devices, safety equipment, and other safety-related matters pertaining to life and property on fixed OCS platforms and drilling vessels.

33 CFR 1 and 153 were revised and published in the *Federal Register* on January 5, 1984. This rule delegates authority to USCG officials to perform pollution response functions under CERCLA.

33 CFR 140-147 provide the USCG with requirements for safety equipment and other matters relating to safety promotion of life and property on the artificial islands and fixed structures located on the OCS, as established in Section 4(c)(1) of the OCSLA.

The Public Notice of the Reception Facilities requirement of the International Convention for the Prevention of Pollution from Ships, 1973, as modified by MARPOL 73/78 was published in the *Federal Register* on June 19, 1984. The proposed regulation provides criteria for determining the adequacy of reception facilities and for administrative procedures for granting Certificates of Adequacy to ports and terminals. The deadline for comments closed August 20, 1984.

On September 9, 1985, the interim rule on reception facilities appeared in the *Federal Register* (50 FR 36768). The proposed rule went into effect March 10, 1986. USCG also published a proposed rule on September 20, 1985, for the Oil and Hazardous Substance Discharge Reporting Requirements. This proposal modifies the procedures for reporting discharges of oil and hazardous substances as required by Section 311 of the FWPCA, as amended, and revises, deletes, and clarifies the language and the criteria for direct payment to the Pollution Fund. The comments were due November 19, 1985. Molten sulphur is not considered a hazardous substance under 40 CFR 117; however, any spill of hydrocarbon or hydrocarbon products would be subject to the reporting requirements (Grimes, personal communication, 1987).

Department of the Interior's Prevention Programs

The MMS, Gulf of Mexico OCS Region, monitors all activities affecting safety and pollution prevention in marine oil and gas and sulphur operations in the Gulf and develops and ensures OCS standards for safety and pollution control equipment and procedures. The MMS OCS Orders are being revised and there currently is a plan to incorporate the OCS Orders into regulation 30 CFR 250. New sulphur regulations are also to be incorporated.

OCS Order No. 7 provides the major specifications for preventing and controlling pollution of the environments (Section I.B.3.b.(1)(f) of Final EIS 110/112).

OCS Order Nos. 2, 5, and 8, with their references to the American Petroleum Institute's Recommended Practices and Standards, contain guidelines for assuring safe operations.

OCS Order No. 10 contains guidelines for sulphur drilling procedures.

Regulations applicable to the BAST program, 30 CFR 250.34(a)(1) and 30 CFR 250.34-2(a)(1)(ii), (v), and (vi), require that special attention be directed to safety and pollution prevention and control features, including oil spill cleanup and containment provisions, in all exploration plans and in all development and production plans. They also describe the safety standards and features and environmental safeguards that will be employed during development and production operations.

Response Measures

The development of contingency guidelines that serve as mechanisms for coordinating an effective response to oil spills is currently being developed and addressed at all levels of government and private industry.

The State of Louisiana does not have a formal written contingency plan; however, the Department of Environmental Quality is developing a set of criteria which defines and establishes a process for notification in the event of a spill. The Department of Environmental Quality represents the State's Regional Response Team (RRT) and coordinates with USCG, USEPA, State Police, the State Department of Fish and Wildlife, and the State Department of Health. As of this writing, there are no plans to develop a state contingency plan for Louisiana.

Offshore sulphur operators are required to submit a contingency plan during the permitting phase for offshore sulphur operations.

National Contingency Plan, as amended, by CERCLA

The revised National Oil and Hazardous Substance Contingency Plan (NCP) was published in the *Federal Register* on March 13, 1982, and went into effect on December 10, 1982. The final revised NCP allows on-scene coordinators (OSC) to authorize the use of dispersants in oil spill cleanups, but only if these dispersants appear on the dispersant acceptance list. The dispersant acceptance list included 28 products tested and accepted under procedures described in the 1981 NCP. For a more detailed discussion of dispersants, see Appendix D of Final EIS 104/105. USEPA has modified a section of proposed Subpart E to differentiate the oil spill cleanup activities for which Federal funds are available under Section 311(k) of the Clean Water Act, the Deepwater Port Act, the OCSLA, and the Trans-Alaskan Pipeline Authorization Act. Revised Subpart G, which designates the agencies that will act as trustees of natural resources lost or damaged following a spill, now includes a section designating states as trustees of the natural resources located within their borders. In addition, this revision incorporates a provision for DOI and DOC to act as co-trustees of resources falling under the jurisdiction of both Federal agencies. An MOU specifies the trusteeship responsibilities of each agency in areas where a pollution incident could affect the natural resources under the authority of both DOI and DOC.

Subpart H, published in the *Federal Register* on July 18, 1984, allows the OSC, with the concurrence of the USEPA representative to the RRT and the concurrence of the states with jurisdiction over the navigable waters polluted by the oil discharge, to authorize the use of dispersants, surface collecting agents, and biological additives on the oil discharge, provided that the dispersants, surface collecting agents, or additives are on the NCP Product

Schedule. However, the OSC may use a product not on the NCP Product Schedule without obtaining the concurrence of the USEPA representative to the RRT of the states when, in the judgment of the OSC, the use of the product is necessary to prevent or substantially reduce a hazard to human life. Afterwards, the OSC is to inform the USEPA RRT representative and the affected states of the use of a product as soon as possible and obtain their concurrence for its continued use once the threat to human life has subsided.

5. Interrelationship With Other Programs and Proposals

a. OCS Oil and Gas Program

Oil and gas leasing on the OCS is administered by DOI under the auspices of the OCSLA, as amended. The Act mandates the orderly development of OCS resources. In response to this requirement, the Secretary of the Interior submits a 5-year lease schedule to the Congress, the Attorney General, and the governors of any affected state. A major objective of the OCS leasing program is to develop needed mineral resources in an environmentally acceptable manner.

As of June 1985, some 20,124 wells had been drilled in the Federal waters off Louisiana for oil and gas. Production from these wells equated to some 6 billion barrels of oil/condensate and 56.8 trillion cubic feet of gas. Since the Federal OCS leasing program began in 1954, a well-developed infrastructure of platforms and pipelines has been established in the Gulf of Mexico.

Experience in coastal and nearshore Louisiana and coastal Texas has shown that sulphur operations and oil and gas operations can successfully co-exist. Federal oil and gas leases in the Gulf of Mexico do not bestow upon the lessee exclusive rights to all mineral resources, but only to the oil and gas resources on that lease. Historically, oil and gas operators and sulphur operators have amicably worked out their differences when there was a potential conflict. An operational constraints stipulation proposed as part of this proposal would further assure that they continue to do so. The lessee which had first received the lease will have the advantage in any decisions toward mitigation of potential conflicts. The new lessee will have to assure that he can operate without unduly impacting the existing or approved operations.

b. Estuarine and Marine Sanctuaries

The Estuarine and Marine Sanctuary programs are discussed in Volume 1, Section I.B.6.a. of the Final Regional EIS. Few changes to the program have taken place since the writing of the Final Regional EIS. See also Section I.B.6.a. of Final EIS 81/84.

Two estuarine sanctuaries, both in Florida, have been established in the Gulf of Mexico: Rookery Bay Estuarine Sanctuary and Apalachicola Bay and River Estuarine Sanctuary. No marine sanctuaries have been established in the Gulf of Mexico.

Both estuarine and marine sanctuaries are designed and managed to meet the following goals, among others:

(1) enhance resource protection through the implementation of a comprehensive, long-term management plan tailored to the specific resources;

(2) promote and coordinate research to expand scientific knowledge of significant marine resources and improve management decisionmaking;

(3) enhance public awareness, understanding, and wise use of the marine environment through public interpretive and recreational programs; and

(4) provide for optimum compatible public and private use of special marine areas.

Only sites with special marine resources are selected for marine sanctuary status. Sites selected for consideration are evaluated on the merits of resource and human use values and on the public benefits to be derived from sanctuary status.

Under the Program Development Plan of January 1982 (described in the Final Regional EIS), NOAA established a number of Regional Resource Evaluation Teams, each to recommend "3 to 5" appropriate sites for consideration as marine sanctuaries. The Gulf of Mexico Team recommended several sites. Of these, four were selected to be placed on the Site Evaluation List (SEL) to receive further study and consideration. (The final SEL was published in 48 FR 35568-35577 on August 4, 1983.) Listing a site on the SEL does not mean that the site is a proposed sanctuary or that it will necessarily be considered as an active candidate for sanctuary designation. However, with few exceptions NOAA will only consider those sites on the SEL for further review as active candidates for marine sanctuary designation. Sites listed on the SEL that have not been reviewed for active candidate status after 5 years will be reevaluated.

Of the four sites placed on the SEL for the Gulf of Mexico, one (the Flower Garden Banks) has been designated an Active Candidate. The Shoalwater Bay-Chandeleur Sound, Louisiana, site is located in the Central Gulf of Mexico, encompassing approximately 80 mi^2 of State waters including seagrass beds and algae. The Baffin Bay, Texas, site in the Western Gulf of Mexico is a bay-estuary system separated from the Gulf by a barrier island. The fourth site is the Big Bend Seagrass Beds in the Eastern Gulf of Mexico.

Recently, the Flower Garden Banks were named an Active Candidate for designation as a national marine sanctuary (49 FR 30988-30991 of August 2, 1984). Selection of the site as an Active Candidate formally triggers the National Environmental Policy Act process. NOAA is preparing a draft management plan and a draft environmental impact statement.

This site, located 110 mi (177 km) offshore, represents the northernmost coral reef community in the Western Gulf of Mexico. The proposed borders of the sanctuary encompass a total of 44 mi2 (114 km^2). The area is a valuable representation of a tropical coral reef community dominated by hermatypic coral (*Montastrea annularis*, *M. cavernosa*, *Porites asteroides*, and *Diploria strigosa*) and associated reef fishes and invertebrates. The nearest bidding unit in the proposed action is some 25 miles from the East Flower Garden Bank.

c. Deepwater Ports

The Deepwater Port Act of 1974 (33 U.S.C. 1501) gives DOT the authority to license deepwater ports. The purpose of a deepwater port is to provide offshore terminal facilities for importation of oil, via pipelines, from tankers too large for conventional ports (primarily supertankers) and to avoid the need for lightering. Presently, in the Gulf, LOOP is the only such port in operation. It is located in 115 ft of water in Grand Isle Block 59, approximately 19 miles from shore. Vessel access to LOOP is by means of the designated fairway, anchorage, and safety zone (Figure I-4 of the Final Regional EIS). No mobile drilling operations or installation of permanent structures may take place in these areas. The North of Gulf and South of Gulf fairways, associated with LOOP, have recently been incorporated into Part 166, Shipping Safety Fairways. This information was published in the *Federal Register* on July 1, 1985 (50 FR 28989).

On August 15, 1985, DOT published in the *Federal Register* (50 FR 32966); the final rule for "Deepwater Port Liability Fund." Part 137 was added to Title 33 and establishes procedures for payment of fees to the Fund, settlement of claims, vessel owner/operator financial responsibility, and notification of spill under the deepwater Port Act of 1974.

d. Offshore Mining

The Secretary of the Interior is authorized under the OCSLA to issue leases for minerals other than oil, gas, and sulphur on the OCS. The Secretary is further supported by federally legislated policy to foster and encourage private enterprise involvement in mining or mineral activities (Mining and Minerals Policy Act of 1955, P.L. 83-217); to foster and encourage private enterprise in the development, reclamation, recycling, and wise disposal of domestic mineral resources (Mining and Minerals Policy Act of 1970, P.L. 91-631); and to encourage Federal agencies to facilitate availability and development of domestic resources to meet critical material needs (The National Materials and Minerals Policy Research and Development Act of 1980). While commercially exploitable mineral commodities are potentially available as surficial or near surficial deposits on the OCS, onshore supplies and an unfavorable economic climate have precluded their development. Recently, a unit sulphur development operations coordination document has been filed with MMS for proposed mining operation in Grand Isle Blocks 16, 17, 22, and 23. Prerequisites for future development are the evaluation of the quality and quantity of the resources, followed by technological advances and a supportive economic climate. For a more detailed discussion of offshore mining, see Volume 1, Section I.B.6.d. of the Final Regional EIS.

e. Ocean Dumping

All ocean dumping is regulated by the Marine Protection, Research, and Sanctuaries Act of 1972 (MPRSA), as amended (33 U.S.C. 1401 et seq.). Regulations (40 CFR 220 et seq.) implementing the Act require a USEPA permit for all ocean dumping of industrial wastes and municipal sludge materials. 33 U.S.C. 1412a mandated the termination of ocean dumping of sewage sludge and industrial wastes by December 31, 1981. 40 CFR 228 lists the designated ocean areas where wastes may be disposed. Further, USEPA has published an annual report entitled "Ocean Dumping in the United States." This report includes information on permit holders, type of waste approved for disposal under the permit, and yearly waste volumes disposed. USEPA has one designated deepwater disposal area in the Gulf of Mexico, as shown on Visual No. 3. The site is designated for the incineration of hazardous wastes.

f. Ocean Incineration

There is one ocean dumping site designated for the incineration of organohalogen wastes in the Gulf of Mexico. This site, shown on Visual No. 3, is in the Western Planning Area (WPA), and is not near to any offering in this proposal.

g. Dredge Material

The dredge is used exclusively for excavation in water. It is used to deepen channels, ports, and harbors and to provide fill material for construction of piers, wharves, docks, underwater foundations, dikes, levees, and related water management structures. Dredging occurs to maintain open channels, canals, and waterways and for the excavation of sand, shell, gravel, and other minerals. Permits issued by COE are required for work on structures in navigable waters of the United States, for the discharge of dredged material or fill into navigable waters, and for transportation of dredged material for the purpose of dumping into ocean waters. COE exercises regulatory authority in navigable waters primarily under the Rivers and Harbors Act of 1899 and the Federal Water Pollution Control Act of 1972. Dredge and fill regulations were revised in July 1975 to include nontidal wetlands. Permits are required by State and local governments, private operators, and other Federal agencies including COE. Permit applications are evaluated to determine the benefits and/or detriments resulting from a proposed action. A permit is issued when it is determined by COE that the proposal is in the overall public interest.

h. National Defense

The U.S. Navy and Air Force actively use nine military warning areas and five water test areas in the Gulf of Mexico, as shown on Visual No. 3. Five of these warning areas lie in the CPA and WPA. Military operations within these warning areas vary in the types of missions performed and their frequency of use. Such missions include carrier maneuvers, missile testing, rocket firing, pilot training, air-to-air gunnery, air-to-surface gunnery, minesweeping operations, submarine operations, air combat maneuvers, aerobatic training, missile testing and development, and instrument training.

In the CPA, space-use conflicts could develop with increased USAF and Navy testing and training activities and unrestricted oil and gas or sulphur development crucial to the Nation's economic and military security. DOI and the Department of Defense (DOD) will work together to assure that Federal offshore development does not conflict with military training. Consultation will take place early and often in the process leading to a lease sale to avoid conflicts and restrictions to the objectives of both departments.

Other general site-specific stipulations have been developed, as necessary, to avoid conflicts and, in irreconcilable cases, areas will be deferred from lease sales. Only one bidding unit in the proposed action falls within a water test area.

i. Louisiana Artificial Reef Program

The Louisiana Artificial Reef Initiative (LARI) has identified eight proposed artificial reef permit areas off the coast of Louisiana. Two of LARI's proposed permit areas occur in bidding units for this proposal: one on the east side of the delta includes four nominated sulphur lease tracts (Main Pass Area Blocks 144 and 145 and Main Pass Area, South Addition blocks 295 and 296 or Sulphur Unit No. 50), and one south of Terrebonne and Lafourche Parishes includes five nominated sulphur lease tracts (South Timbalier Blocks 131, 132, 134, 135, and 151 or Sulphur Unit Nos. 38 and 39). The development of site specific artificial reef construction sites within any block leased for sulphur operations will require coordination between the sulphur lease operator and the administrator of the State's artificial reef program. Reef construction will be prohibited in areas of active sulphur operations (production sites, platforms, and pipelines) and identified zones of potential subsidence.

During the permitting stage of either operation, MMS will assure that proper coordination takes place.

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II. ALTERNATIVES INCLUDING THE PROPOSED ACTION

A. ALTERNATIVE A - THE PROPOSED ACTION

1. Description of the Proposed Action

The proposed action is to offer for lease 51 bidding units containing a total of 153 blocks and about 725,000 acres of submerged land in the CPA of the Gulf of Mexico (Sulphur/Salt Sale Visual) for the exploration, development, and production of sulphur/salt. The proposed action also proposes that the following lease stipulations be attached for further mitigation to each bidding unit that is leased: archaeological resource stipulation (Section II.A.3.a.); military areas stipulation (Section II.A.3.b.); and operational constraints NTL, Letter to Lessees (LTL), or stipulation (Section II.A.3.c.).

The analyses of impacts summarized in Section II.A.2. and described in detail in Section IV.C.1. are based on a development scenario formulated to provide a set of assumptions and estimates on the amounts, and timing for OCS exploration, development, and production operations and facilities, both offshore and onshore. Table IV-1 summarizes major elements of the development scenario for the proposed action. A detailed discussion of the development scenario and major related impact producing factors is included in Section IV.A. The following major assumptions and estimates are included in the development scenario:

- The discovery, development, and production of 55 million long tons of sulphur during the period 1989-2022.

- The drilling of 60 exploration and delineation wells during the period 1989-1995.

- The installation of 9 production platforms, 3 power plant platforms, 6 auxiliary platforms, and the drilling of 324 development and 576 sidetrack wells during the period 1992-2012.

- Sulphur production beginning in 1992, reaching peak annual production during the period 1998-2011, and ending in 2022.

- All sulphur production transported by barge to existing Gulf Coast port terminal and storage facilities.

- The construction of 40 miles of offshore pipeline to carry fuel (gas) and water to the sulphur mines.

- The construction of possibly 2 (0-2) pipeline landfalls (with a small amount of onshore routing) to carry water and gas to offshore mining sites.

- Onshore support is expected to be provided from facilities existing prior to the proposed action.

- One salt well will be drilled per mine and the salt used in the sulphur mining process will amount to a total of 15 million short tons for the three mines. All salt mined is consumed on-site as brine in the sulphur mining process and is discharged as bleedwater.

2. Summary of Impacts

a. Impacts on Sensitive Coastal Habitats

(1) Barrier Beaches/Islands

The major impact producing factors related to the proposed action which could potentially affect the Gulf's barrier beaches include pipeline emplacement, support infrastructure construction, navigation canal construction and maintenance, sulphur spills, oil spills resulting from interference with oil production facilities or blowouts, and discarded trash and debris. The latter topic is discussed in Section IV.D.1.j.

No pipelines are expected to be constructed for the transport of produced sulphur to shore. However, it is possible that up to two small pipelines may be constructed for the purpose of supplying fresh water and fuel gas to potential production sites within close proximity to land. No new ancillary facilities or new navigation canals are expected, but maintenance dredging of existing navigation canals will occur periodically. The chance of a sulphur barge spilling its cargo onto a barrier island/beach is unlikely; however, if such an event occurred, the impacts would be localized and temporary with the greatest impacts resulting from loss of beach sand during cleanup. Oil spills resulting from sulphur operations interfering with oil production facilities or blowouts are highly unlikely.

The short-term nature and relatively small area of disturbance expected to result from the emplacement of pipelines and the minimal probabilities of any oil spill contacts indicate that the impacts of the proposed action on barriers beaches/islands will be very low.

(2) Wetlands

Up to two pipeline landfalls and minor maintenance dredging are expected in the CPA as a result of the proposed action. It is unlikely a sulphur barge will sink or spill sulphur offshore or in a river or canal. It is unlikely any sulphur spills or secondary oil spills will occur and contact wetlands in the CPA as a result of the proposed action. The level of impact on coastal wetlands as a result of the proposed action is expected to be very low in coastal subareas C-1, C-2, C-3, and C-4. The level of impact on coastal wetlands in the Central Coastal Area (CCA) resulting from the proposed action is expected to be very low.

b. Impacts on Sensitive Offshore Habitats

The potential impacts of this proposal on the sensitive biota of topographic features (banks) and live bottoms are considered to be very low. There are several reasons for this: (1) the blocks containing the banks and the associated sensitive biota are not being offered in this proposal; (2) no blocks near enough to the banks to require a biological stipulation such as that imposed on oil and gas leases are offered in this proposal; (3) secondary oil spills resulting from this proposal are not likely to occur; (4) because the blocks containing the sensitive biota are not included in this proposal, subsidence is not likely to effect the sensitive areas; and (5) no areas likely to contain live bottom areas are offered in the proposal.

The U.S. Environmental Protection Agency (USEPA) also has some jurisdiction over discharges into the Gulf through their National Pollutant Discharge Elimination System (NPDES) permits. A Gulf-wide General Permit went into effect in July 1986 (51 FR 24897) for oil and gas operations. Although we cannot speculate on future permitting actions by another agency, since sulphur drilling is similar to oil and gas drilling, it is possible that USEPA will permit routine drilling discharges on any sulphur leases resulting from this proposal to be covered by permit conditions similar to those of the General Permit. However, an individual NPDES permit will be required for those discharges as well as for bleedwater discharges. Permit conditions required by USEPA may include no discharge, a limitation on the rate of discharge, shunting, or a monitoring program to assess the impact of the discharge.

c. Impacts on Water Quality

As a result of the proposal, localized water quality degradation would occur in the offshore waters adjacent to Louisiana. Immediate impacts would be brought on by increased drilling of up to 60 exploration/delineation wells, 324 development wells, 576 sidetrack wells, and construction and pipelaying activities resulting from the laying of up to 40 miles of pipeline. Other impacts would stem from additional dredging activities and discharges of drilling muds, fluids, cuttings, sanitary and domestic wastes, and formation waters from the three major complexes projected for this proposal. The expected impacts are estimated to be moderate to high around platforms and construction sites depending on existing local water conditions, with the extent of such impacts extending from only a few meters to tens of meters from these sites. These impacts will decrease to very low with distance (500-1,000 m) from the source. The overall impact to offshore water quality is expected to be low. There will likely be no impact to onshore water quality resulting from the proposal.

d. Impacts on Air Quality

Air quality degradation may occur from catastrophic events (blowouts) and offshore operational emissions as a result of drilling, platform installation, and production. Impacts resulting in slight increases of some criteria pollutants are assumed to be in areas classified as nonattainment or Prevention of Significant Deterioration (PSD) Class I areas that may be adjacent to more dense OCS-related activities, i.e., Mobile County in Alabama and St. Bernard, Plaquemines, St. Mary, Lafourche, St. Charles, Jefferson, Orleans, and St. John the Baptist Parishes in Louisiana. Coastal air quality could deteriorate if an unflared blowout causes the uncontrolled release of sour gas into the atmosphere within 3-5 miles of shore. The expected levels of OCS-related activities (3 complexes) should cause little long-term degradation of ambient air quality with no significant effects on nonattainment or PSD areas. (For a detailed analysis, see Section IV.C.1.d.) Low impacts would be expected in St. Bernard, Plaquemines, St. Mary, Lafourche, St. Charles, Jefferson, Orleans, and St. John the Baptist Parishes in Louisiana and in Mobile County in Alabama. Very low impacts are expected throughout the remainder of the coastal area of the Central Gulf.

e. Impacts on Endangered and Threatened Species

The impact producing factors which could affect endangered and threatened species as a result of the proposed action include sulphur spills or secondary oil spills, collision with barges and/or vessels, coastal construction, debris and trash, and removal of platform legs/pilings with explosives (USDI, MMS, 1987a and Section IV.A.3.j. of Draft EIS 113/115/116 (USDI, MMS, 1987b)).

(1) Brown Pelicans

It is unlikely any sulphur spills or secondary oil spills will occur and contact pelicans or their habitat in the CPA. There is a very low potential of injury or death of brown pelicans from entanglement or ingestion of debris and trash. Up to two pipeline landfalls, and minor maintenance dredging are expected to result from the proposed action in the CPA. The level of impact on brown pelicans is expected to be very low.

(2) Sea Turtles

It is unlikely any sulphur spills or secondary oil spills will occur and contact sea turtle foraging areas off Louisiana or Texas. Barge and vessel traffic is estimated at less than 1% of the annual vessel traffic in the CPA and is not likely to impact sea turtles. There is a very low potential of injury or death of sea turtles from entanglement or ingestion of debris and trash. Explosive removal of platform legs/pilings could affect sea turtles near the detonation; however, it is expected that removal technology will be developed which will prevent injury to turtles. Up to two pipeline landfalls and minor maintenance dredging are expected to result from the proposed action in the CPA. The level of impact on sea turtles is estimated to be very low.

f. Impacts on Marine Mammals (Whales)

It is unlikely any sulphur spills or secondary oil spills will occur and contact areas of the continental shelf where marine mammals occur. Barge and vessel traffic is estimated at less than 1% of annual vessel traffic in this coastal area and is not likely to impact marine mammals. There is a very low potential of injury or death of marine mammals from entanglement or ingestion of debris and trash. Explosive removal of platform legs/pilings could affect marine mammals near the detonation. The disturbance and noise associated with site specific seismic exploration and drilling will be short-term and localized near drilling sites. The level of impact on marine mammals is expected to be low.

g. Impacts on Coastal and Marine Birds

The impact producing factors which could affect coastal and marine birds as a result of the proposed action include sulphur spills or secondary oil spills, coastal construction, and debris and trash. It is unlikely that sulphur/oil spills will occur and contact coastal and marine bird habitat. There is a very low potential of injury or death of coastal and marine birds from entanglement or ingestion of debris and trash Up to two pipeline landfalls and minor maintenance dredging are expected to result from the proposed action in the CPA. The level of impact on coastal and marine birds is expected to be very low.

h. Impacts on Adjacent Existing Oil and Gas Operations

Three sulphur mines are expected to result from this proposal. For those three mines, the impact producing factors which could adversely affect adjacent existing oil and gas operations would be physical damage from platform or drill rig emplacement, pipeline emplacement, or anchoring; the physical presence of drill rigs, platforms, and support vessels; and, most importantly, the threat of subsidence caused by sulphur mining activity.

Authority is granted to the Director in 30 CFR 250 to regulate OCS minerals operations in an orderly, safe, and environmentally acceptable manner. That authority would also allow the formulation of an NTL, LTL, OCS Order, or operational constraints stipulation to offer further mitigation. Thus, with the permit review procedures for exploration or development and production, and the Director's authority to impose restrictions as necessary to avoid conflicts, impacts to adjacent oil and gas operations is expected to be very low. The level of any sulphur activity resulting from this proposal is so small compared to the oil and gas industry as a whole, that any impacts to the oil and gas industry would be very low.

i. Impacts on the Commercial Fishing Industry

Several impact producing factors from the proposed action could affect the commercial fishing industry, including loss of fishing area through construction of platforms/structures, platform removal by explosives, oil spills, drilling and production discharges, and underwater obstructions. As a result of these impact producing factors, a very low impact (a 0.01% or less economic loss to the commercial fishing industry and a few fishermen affected) is expected to occur to the commercial fishing industry.

j. Impacts on Major Shorefront Recreational Beaches

The proposed sulphur/salt sale is expected to have a very low, if any, impact on the quality and use of major Gulf of Mexico shorefront recreational beaches in Louisiana and Texas. Should impacts be detectable on Gulf-front beaches, it is most likely to result from persistent marine debris or trash derived from accidents or illegal trash dumping from offshore sulphur operations.

k. Impacts on Archaeological Resources

(1) Historic

The impact producing factors which would affect offshore and onshore historic sites include interactions with drilling rigs, platforms, pipelines, and anchors, and subsidence of the seafloor after mining. Should an interaction between one of these impact producing factors and an historic site occur, significant or unique historic information could be lost. The potential for such an interaction occurring due to onshore development or oil spills is estimated to be very low; thus, the level of impacts is expected to be very low.

The archaeological survey reduces the potential for a very high impact from offshore development to very low by allowing sites to be located prior to an interaction occurring, thereby making avoidance or mitigation of impacts possible. The survey's effectiveness in subplanning areas C-2 and C-3, where the potential for a very high impact level exists, would be reduced because of thick unconsolidated sediments which make the magnetometer the primary instrument for shipwreck detection. At 150 m linespacing the magnetometer provides only 25%-30% coverage of the survey area. In areas other than subplanning areas C-2 and C-3, the expected level of impact is very low. In subplanning areas C-2 and C-3 the expected impacts is uncertain, but it could be very high. Although the impacts could be very high if an interaction occurred, the probability of such an interaction is considered very low due to the evaluations afforded by other information, including that provided under the requirements of NTL-75-3 (Revision No. 1).

(2) Prehistoric

All of the impact producing factors which could affect offshore and onshore historic sites could affect prehistoric sites as well. Should an interaction between one of these impact producing factors and a prehistoric site occur, significant or unique archaeological information could be lost. The potential for such an interaction occurring due to onshore development and oil spills is estimated to be very low; thus, the level of impact is expected to be very low.

The archaeological survey reduces the potential for a very high impact to very low by allowing potential site areas to be located prior to an interaction occurring, thereby making avoidance or mitigation of impacts possible. The expected level of impact is very low.

l. Socioeconomic Impacts

The impact on local employment, income, and population due to the proposed sulphur sale is expected to occur throughout the region from 1989-2022. The total existing sulphur-related employment in the region as of 1984 is 4,800 while the population is 11,040. Existing payroll is estimated at $130 million. The total projected employment for the proposed sulphur sale is 5,200 while population is 11,960. Projected payroll is estimated at $145 million. However, the sulphur sale will attract no new residents to the region, but instead will provide employment to existing residents, probably displaced oil and gas workers. Thus, the expected level of impact on local employment, income, and population is expected to be very low.

3. Proposed Mitigating Measures

The impact analysis for this document was based on the assumption that the necessary mitigating measures to conduct sulphur operations in a safe and environmentally acceptable manner are contained in current regulations (30 CFR 250); and, if deemed necessary by the Director, specific requirements may be implemented through the formulation of lease stipulations, NTL's or LTL's in order to provide further mitigation. The regulatory basis for this assumption is discussed below. Those resources or operations identified in the analysis where additional mitigation might be necessary are topographic features, military operations and protection of the structural integrity of facilities constructed by existing oil and gas operations (operational constraints).

According to the regulations at 30 CFR 250.10(a), "...all operations conducted pursuant to a lease by or on behalf of a lessee are subject to the regulations in this part and are under the jurisdiction of the Director." Part (b) of 30 CFR 250.10 states that ".. the Director is authorized and directed to act upon the requests, applications, and notices submitted under regulations in this part, and to require compliance with applicable laws, regulations, lease terms, and OCS Orders so that all operations are conducted in a manner which will protect the natural resources of the OCS. The Director may issue OCS Orders to implement the requirements of the regulations in this part. The Director may issue other orders, either written or oral, to govern lease operations." Furthermore, regulations under 30 CFR at part 250.11(a) state that the Director shall "(1) Regulate all operations conducted under a lease or permit and shall issue and amend OCS Orders and other orders and field rules as may be necessary and proper in order to supervise operations and to prevent harm or damage to, or waste of, any natural resource (including any mineral deposits in areas leased or not leased), any life (including fish and other aquatic life), property, or the marine, coastal, or human environment."

Requirements for lessees are set forth in 30 CFR 250.30. Regulations in part (a) require the lessee "to comply with the provisions of all applicable laws, regulations, the lease, OCS Orders, and other written or oral orders of the Director." Part (b) of 30 CFR 250.30 further requires the lessee to "conduct operations on a lease in a manner that does not, in the opinion of the Director, cause or threaten to cause waste or threaten harm or damage to life (including fish and other aquatic life), to property, to any mineral deposits (in areas leased or not leased), to the national security, or to the marine, coastal, or human environment, and the lessee shall take all necessary precautions to prevent waste, harm, or damage."

Further applicable regulations at 30 CFR 250.11(a)(2) and 250.30(c) mandate the Director to require, and the lessee to use, the best available and safest technology on all new and, whenever practicable, existing drilling and production operations.

Any further mitigating measures necessary to assure safe operations are applied at the time of permit approval as set forth in 30 CFR 250.34. Requirements in 30 CFR 250.34-1 prohibit any exploration activities, except for preliminary activities, without submission and approval of an exploration plan. Preliminary activities are defined as geological, geophysical, and other surveys required for the preparation of the exploration plan. Such preliminary activities are those which do not result in physical penetration of the seabed of greater than 300 ft in unconsolidated formations, or 50 ft in consolidated formations, and which do not result in any significant adverse impacts to any OCS resources. The exploration plan must include the proposed type and sequence of exploration activities to be undertaken; a description of any drill rigs or platforms to be used along with special attention to safety features and pollution-prevention and control features including oil spill containment and cleanup plans; the general location of each proposed exploratory well (both surface and bottom hole locations); structure maps and schematic cross sections showing marker horizons; and Environmental Report; and any other information the Director may require.

Requirements similar to those prescribed for exploration plans are set forth in 30 CFR 250.34-2 for development and production plans.

Thus, sufficient authority exists in current regulations for the promulgation of any mitigating measures necessary for the protection of the environment and to avoid any conflicts between future sulphur operations and military or existing oil and gas facilities.

a. Archaeological Resource Stipulation

An Archaeological Resources Stipulation consistent with the one applied to oil and gas leases is proposed for any sulphur/salt lease resulting from this sale. The stipulation reads as follows:

(1) "Archaeological resource" means any prehistoric or historic district, site, building, structure, or object (including shipwrecks); such term includes artifacts, records, and remains which are related to such a district, site, building, structure, or object. (Section 301(5), National Historic Preservation Act, as amended, 16 U.S.C. 470w(5). "Operations" means any drilling, mining, or construction or placement of any structure for exploration, development, or production of the lease.

(2) If the Regional Director (RD) believes an archaeological resource may exist in the lease area, the RD will notify the lessee in writing. The lessee shall then comply with subparagraphs (a) through (c).

(a) Prior to commencing any operations, the lessee shall prepare a report, as specified by the RD, to determine the potential existence of any archaeological resource that may be affected by operations. The report, prepared by an archaeologist and geophysicist, shall be based on an assessment of data from remote-sensing surveys and of other pertinent archaeological and environmental information. The lessee shall submit this report to the RD for review.

(b) If the evidence suggests that an archaeological resource may be present, the lessee shall either:

(i) Locate the site of any operation so as not to adversely affect the area where the archaeological resource may be; or

(ii) Establish to the satisfaction of the RD that an archaeological resource does not exist or will not be adversely affected by operations. This shall be done by further archaeological investigation, conducted by an archaeologist and a geophysicist, using survey equipment and techniques deemed necessary by the RD. A report on the investigation shall be submitted to the RD for review.

(c) If the RD determines that an archaeological resource is likely to be present in the lease area and may be adversely affected by operations, he will notify the lessee immediately. The lessee shall take no action that may adversely affect the archaeological resource until the RD has told the lessee how to protect it.

(3) If the lessee discovers any archaeological resource while conducting operations on the lease area, the lessee shall report the discovery immediately to the RD. The lessee shall make every reasonable effort to preserve the archaeological resource until the RD has told the lessee how to protect it.

There are two archaeological management zones in the Gulf of Mexico (Figure II-1 of Final EIS 110/112). Zone 1 has a high potential both for the occurrence of historic shipwrecks and for prehistoric sites. Zone 2 has a high potential only for prehistoric sites. All tracts leased, which fall within Archaeological Zones 1 or 2, will require a remote sensing survey as specified in NTL 75-3 (Revision No. 1). Additionally, all tracts containing known shipwrecks (Table III-18 of Final EIS 110/112) which fall outside Zones 1 and 2 would require surveys at 150 m linespacing, if leased. The lessees will be notified in writing after the lease sale regarding the archaeological survey requirement on their lease.

Effect of the Lease Stipulation

The lease stipulation reduces the potential for an interaction between an impact producing factor and an archaeological site by allowing sites to be located prior to lease development, thereby making avoidance or mitigation of impacts possible.

b. Military Areas Stipulation

The following proposed stipulation is identical to the one applied to the oil and gas leases in the military areas. The military has supported joint usage of the areas with the stipulation in place. Main Pass Block 289, located in Eglin Water Test Area 1, is the only block in the proposed action that will be affected by the stipulation. The Command Headquarters for the area is: Commander, Armament Division, Eglin Air Force Base, Florida 32542.

Military Areas Stipulation

Hold and Save Harmless

Whether compensation for such damage or injury might be due under a theory of strict or absolute liability or otherwise, the lessee assumes all risks of damage or injury to persons or property, which occur in, on, or above the outer continental shelf, to any persons or to any property of any person or persons who are agents, employees, or invitees of the lessee, its agents, independent contractors, or subcontractors doing business with the lessee in connection with any activities being performed by the lessee in, on, or above the outer continental shelf, if such injury or damage to such person or property occurs by reason of the activities of any agency of the United States government, its contractors or subcontractors, or any of their officers, agents or employees, being conducted as a part of, or in connection with, the programs and activities of the command headquarters.

Notwithstanding any limitation of the lessee's liability in the lease, the lessee assumes this risk whether such injury or damage is caused in whole or in part by any act or omission, regardless of negligence or fault, of the United States, its contractors or subcontractors, or any of its officers, agents, or employees. The lessee further agrees to indemnify and save harmless the United States against all claims for loss, damage, or injury sustained by the lessee, or to indemnify and save harmless the United States against all claims for loss, damage, or injury sustained by the agents, employees, or invitees of the lessee, its agents, or any independent contractors or subcontractors doing business with the lessee in connection with the programs and activities of the aforementioned military installation, whether the same be caused in whole or in part by the negligence or fault of the United States, its contractors, or subcontractors, or any of its officers, agents, or employees and whether such claims might be sustained under a theory of strict or absolute liability or otherwise.

Electromagnetic Emissions

The lessee agrees to control its own electromagnetic emissions and those of his agents, employees, invitees, independent contractors or subcontractors emanating from individual designated defense warning areas in accordance with requirements specified by the commander of the command headquarters to the degree necessary to prevent damage to, or unacceptable interference with, Department of Defense flight, testing or operational activities, conducted within individual designated warning areas. Necessary monitoring control, and coordination with the lessee, its agents, employees, invitees, independent contractors or subcontractors, will be affected by the commander of the appropriate onshore military installation conducting operations in the particular warning area; provided, however, that control of such electromagnetic emissions shall in no instance prohibit all manner of electromagnetic communication during any period of time between a lessee, its agents, employees, invitees, independent contractors or subcontractors and onshore facilities.

Operational

The lessee, when operating or causing to be operated on its behalf, boat or aircraft traffic into the individual designated warning areas, shall enter into an agreement with the commander of the individual command headquarters upon utilizing an individual designated warning area prior to commencing such traffic. Such an agreement will provide for positive control of boats and aircraft operating into the warning areas at all times.

Effect of the Lease Stipulation

Although any conflict between future sulphur operations are unlikely since the one tract in this sale is on the western edge of a water test area, the hold harmless section of the military stipulation serves to protect the U.S. Government from liability in the event of an accident involving the lessee and military activities. The actual operations of the military and the lessee and its agents will not be affected.

The electromagnetic emissions section of the stipulation requires the lessee and its agents to reduce and curtail within some areas the use of radio, CB, or other equipment emitting electromagnetic energy. This serves to reduce the impact of lease activity on the communications of military missions and reduces the possible effects of electromagnetic energy transmissions on missile testing, tracking, and detonation.

The operational section requires notification to the military of minerals activity to take place within a military use area. This allows the base commander to plan military missions and maneuvers to avoid the areas where minerals activities are taking place, or to schedule around the activities. Prior notification helps to reduce the potential impacts associated with vessels and helicopters traveling unannounced through areas where military activities are underway.

The military stipulation reduces potential impacts, particularly in regards to safety, but does not reduce or eliminate the actual physical presence of OCS operations in areas where military operations are conducted. The best indicator of the overall effectiveness of the stipulation may be that there has never been an accident involving a conflict between military operations and OCS activities.

c. Operational Constraints

If additional mitigation in the form of direct guidance is deemed advisable by the Director, specific requirements for the avoidance of conflicts between future sulphur operations and existing or permitted oil and gas operations could be formulated and presented in the form of a stipulation to be attached to each lease, an NTL, LTL, or OCS Orders. Such potential conflicts are discussed in Section IV.C.1.h. Thus, the NTL, LTL, or stipulation would serve to inform each sulphur/salt lessee what actions might be expected of them in order to avoid any adverse impacts to adjacent existing or permitted oil and gas operations. If a stipulation were decided upon, a draft of the proposed stipulation would read as follows:

(1) Sulphur exploration or development activities shall be conducted in such a manner that they will not unduly interfere with prior rights or approvals for oil and gas exploration and/or development activities.

(2) Exploration or development plans for proposed sulphur activities shall include the showing of notice to existing oil and gas operators or pipeline permittees whose existing or approved activities may be affected by the proposed sulphur activities.

(3) With respect to sulphur development activities, the Minerals Management Service may, if determined necessary as a means of safeguarding life and the environment, impose various operational constraints including but not limited to the following:

  (a) The establishment of "no activity zones" in the vicinity of certain existing or approved oil and gas activities.

  (b) The delaying of sulphur development activities until such time that the potential for negative impact is at an acceptable level or no longer exists.

Effect of the Mitigating Measure

This NTL, LTL, or stipulation would require a case-by-case analysis of any action the sulphur lessee might undertake during exploration, development, or production activities to assure that the action would not unduly interfere with either approved or existing oil and gas operations on the lease. The exploration or development plan for sulphur activities would include the notice to existing oil and gas lessees to assure that the oil and gas lessee is advised of the proposed actions of the sulphur lessee. Finally, this requirement would afford MMS the means to impose various operational constraints in order to protect life and the environment from impacts of sulphur activities to oil and gas infrastructure. Such constraints may include, but are not limited to, delaying any sulphur operation in the vicinity of oil or gas operations where adverse impacts might occur until the oil or gas operations are terminated and structures or pipelines are removed; creation of a no activity buffer zone around pipelines or platforms to assure that they will not be affected by subsidence; or relocation of any structures or pipelines prior to sulphur operations.

B. ALTERNATIVE B - DELETE TRACTS WITH ACTIVE OIL AND GAS LEASES

1. Description of the Alternative

This alternative would delete 125 of the 153 blocks proposed for offering in this action (as of March 27, 1987 - the actual number would change as oil and gas leases are terminated or relinquished), and all of the 51 bidding units except two would be affected, 34 of which would be completely eliminated. Those tracts which had active oil and gas leases as of March 27, 1987 are:

Area	Blocks
WCW	306
WCS	522
EC	104, 118, 178, 185, 229
ECS	303, 311
VR	124, 161, 162, 164, 190, 203, 204, 217, 218, 225, 226
SMI	8, 33, 38, 39, 58, 69, 70
SMIN	288
SMIS	71, 72, 73, 132
EI	62, 63, 76, 77, 89, 94, 95, 110, 111, 119, 120, 125, 126, 128, 128A, 129A, 158, 172, 176, 184, 188, 189, 190, 191, 205, 208, 218, 227, 237, 238, 252, 253
SS	30, 31, 32, 33, 149, 154, 208, 209, 214, 215, 218, 219, 229, 230
SSS	242, 268, 269, 275
PL	11, 12, 19, 20
ST	63, 86, 131, 134, 135, 151, 160, 161, 176, 177
GI	72
GIS	86
WD	30, 31
WDS	121, 122, 133, 137, 138, 152
MC	267, 357, 358
SP	60, 61
SPSE	67, 70, 88, 89, 93, 94
MP	72, 144
MPSE	289, 296, 299, 305, 306

Abbreviations:

WCW - West Cameron West Addition
WCS - West Cameron South Addition
EC - East Cameron
ECS - East Cameron South Addition
VR - Vermilion
VRS - Vermilion South Addition
SMI - South Marsh Island
SMIN - South Marsh Island North Addition
SMIS - South Marsh Island South Addition
EI - Eugene Island
EIS - Eugene Island South Addition
SS - Ship Shoal
SSS - Ship Shoal South Addition
PL - South Pelto
ST - South Timbalier
GI - Grand Isle
GIS - Grand Isle South Addition
WD - West Delta
WDS - West Delta South Addition
MC - Mississippi Canyon
SP - South Pass
SPSE - South Pass South and East Addition
MP - Main Pass
MPSE - Main Pass South and East Addition

This alternative is offered since there is a possibility that sulphur operations will have some slight impact on existing oil and gas operations in the vicinity of the tracts offered in this proposal. Oil and gas operations could be adversely affected by the physical presence of drill rigs, platforms, and vessels supporting sulphur operations.

Subsidence associated with sulphur production could result in damage or loss of oil and gas pipelines and platforms. Mining fluids injected into cap rock to mine sulphur may corrode or overpressure oil or gas well casings, and result in failure.

2. Summary of Impacts

Impacts of the proposal on existing or planned oil and gas operations are expected to be very low; adoption of Alternative B would further reduce the potential conflicts of future sulphur operations on existing or planned oil and gas operations from very low to essentially non-existent. The deletion of the 128 tracts in this alternative would prevent the recovery at this time of any producible quantities of sulphur that these tracts might contain.

C. ALTERNATIVE C - DELETE TRACTS WITH PIPELINES

1. Description of the Alternative

This alternative would delete 128 blocks which contain oil or gas pipelines from the proposed sale. The adoption of of this alternative would affect 48 of the 51 bidding units in the proposed sale, 34 of which would be completely eliminated. Those tracts which contain oil or gas pipelines are shown in Figures IV-2 through IV-13, and are:

Area	Blocks
WC	263, 272
WCS	544
EC	104, 118, 155, 184, 185, 229
ECS	293, 303, 311
VR	124, 161, 162, 164, 179, 190, 217, 218, 225, 226
SMI	8, 33, 38, 58, 69, 70
SMIN	288
SMIS	71, 72, 73, 132
EI	62, 63, 76, 77, 89, 94, 95, 116, 119, 120, 125, 126, 128, 128A, 129, 129A, 157, 158, 172, 175, 176, 184, 188, 189, 190, 191, 205, 208, 218, 227, 237, 238, 252, 253
SS	30, 31, 32, 33, 149, 154, 208, 209, 214, 215, 218, 219, 229, 230
SSS	242, 268, 269, 274, 275
PL	11, 12, 19, 20
ST	63, 86, 131, 132, 134, 135, 151, 160, 161, 176, 177
GI	72
GIS	86
WD	30, 31
WDS	121, 122, 133, 134, 137, 138, 152
SP	60, 61
SPSE	67, 70, 88, 89, 93, 94
MP	72, 144,
MPSE	289, 295, 296, 299, 305, 306

(Abbreviations are shown in Section II.B. above.)

This alternative is offered since there is a possibility that sulphur mining operations could have adverse effects on oil or gas pipelines. Pipelines could suffer physical damage by the placement of drill rigs, platforms, or anchors, and could be subjected to subsidence caused by sulphur mining. Such damage could result in a small to moderate oil spills.

2. Summary of the Impacts

Impacts of the proposal to existing pipelines are expected to be very low; adoption of Alternative C would further reduce the impacts to existing pipelines, and thus the possibility of oil spills related to pipeline damage, from very low to extremely low. The size of the sale would be reduced by 82% and, to the extent that these prospects have producible quantities of sulphur, adoption of this alternative would prevent its recovery at this time.

D. ALTERNATIVE D - DELETE MILITARY AREAS

1. Description of the Alternative

This alternative would delete the one tract (Main Pass South and East Addition, Block 289) located in the Eglin Water Test Area 1 (EWTA 1). EWTA 1 is used by the U.S. Air Force for rocket and missile testing. The one block that is subject to this alternative is located on the western boundary of EWTA 1.

This alternative is offered since there is a slight possibility of use conflicts between military operations and potential sulphur operations. The adoption of this alternative would preclude the need for the proposed military areas stipulation (Section II.A.3.b.).

2. Summary of Impacts

Impacts of the proposal on military operations are expected to be low; adoption of Alternative D would further reduce the potential for space-use conflicts between sulphur operations and military operations from low to non-existent. To the extent that this prospect contains producible quantities of sulphur, adoption of this alternative would prevent its recovery at this time.

E. ALTERNATIVE E - DELAY THE SALE

1. Description of the Alternative

While there are no known specific issues that might cause a delay at this time, it is possible that a delay could occur for reasons that may arise before the sale is finalized. Delaying the sale would withhold nominated blocks in this area for an indefinite period of time.

2. Summary of Impacts

All impacts associated with Alternative A, as discussed in Section II.A.1., would be delayed until such time as the sale is reinstated.

F. ALTERNATIVE F - NO ACTION

1. Description of the Alternative

This alternative is equivalent to cancellation of the sale. Sulphur/salt sales are scheduled in the Gulf of Mexico Region on a need basis. Therefore, the opportunity would be foregone for development of the estimated 55 million tons of sulphur that could have resulted from this sale.

2. Summary of Impacts

All impacts, positive and negative, associated with the proposed action would be canceled and the importation of foreign sulphur at present or increased levels would continue. Impacts from Alternative F would result in no effect on environmental resources. Adverse socioeconomic impacts could include loss of employment opportunities, payroll revenues, and tax revenues. Potential economic benefits in the coastal region would be lost. Development of alternative sulphur supplies as replacement resources for lost domestic OCS production include importation from Mexico, Canada, and other countries.

G. COMPARISON OF ALTERNATIVES

Table S-2 provides a comparison and summary of the impact levels of the proposed action (Alternative A), deletion of tracts with active oil and gas leases (Alternative B), deletion of blocks containing oil and gas pipelines (Alternative C), deletion of the block in a military area (Alternative D), delay the sale (Alternative E), no action (Alternative F), and the cumulative analyses for this sale. The definitions of the levels of impact used are in Table S-3.

Alternative A, the proposed action (M Scenario), has the potential to result in moderate to very low impacts to all of the resources analyzed. No impact to local tourism is anticipated. The archaeological resource, and military areas stipulations, and operational constraints stipulation are being proposed for adoption as additional mitigating measures. Without the operational constraints stipulation, potential impacts to adjacent existing oil and gas operations in the vicinity of future sulphur activities would be very low. With the stipulation, the Director would have the means to offer additional mitigation to the authority already in place in the regulations (30 CFR 250), the lessees would have a better idea of what would be expected of them in order to avoid potential impacts, and the impact to adjacent existing oil and gas operations is expected to remain very low.

Alternative B, deletion of blocks with active oil and gas leases, would further reduce the potential for conflicts between sulphur operations and existing oil and gas operations from low to essentially nonexistent. The level of impact to most resources analyzed would be reduced from those anticipated in Alternative A since the size of the sale would be greatly reduced.

Alternative C, deletion of blocks containing oil or gas pipelines, would further reduce the potential for damage to pipelines resulting from emplacement of drill rigs, platforms, or anchors, and from subsidence caused by sulphur mining from very low to extremely low. With the adoption of this alternative, the very remote chance of oil spills resulting from pipeline damage would be further reduced from very low to extremely low. The level of impact to most resources would likely be reduced from those anticipated in Alternative A since the size of the sale would be reduced by 82%.

Alternative D, deletion of the one block in a military area, would further reduce the slight potential for conflicts between sulphur operations and military operations from low to nonexistent. The level of impact to various resources analyzed would be the same as those anticipated in Alternative A.

Alternative E, delay the sale, would postpone any potential adverse impacts until a later time. The level of impacts would have to be evaluated at that time; however, the overall levels of impact on the resource categories analyzed are not likely to change from those anticipated for Alternative A.

Alternative F, no action, equates to cancellation of the sale and would preclude any impacts to the resource categories listed in Table S-2 from the proposed action or other alternatives.

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III. DESCRIPTION OF THE AFFECTED ENVIRONMENT

A. PHYSICAL ELEMENTS OF THE ENVIRONMENT

1. Environmental Geology and Hazards

a. Geology (and the Formation of Cap Rock Sulphur)

The entire northern Gulf of Mexico coastal region is underlain by a thick sequence of evaporites, principally salt, known as the Louann Salt. Deep well data from south Arkansas, northeast Texas, and north Louisiana revealed stratigraphic relationships of overlying Upper Jurassic rocks which led Hazzard et.al. (1947) to the conclusion that the Louann Salt was of Permian age. Although the exact age of the Louann Salt is still uncertain, subsequent work by Halbouty and Hardin (1956), Humphrey (1956), Mixon et al. (1959), and Murray (1961) indicates that the age is probably Upper Triassic-Lower Jurassic.

Following deposition of the Louann Salt, the thick sequence of evaporites has been buried under thousands of feet of sediments. Under the pressure created by the great weight of overburden, the salt became plastic in nature and began to flow. Parker and McDowel (1951 and 1955) found that salt flow can be initiated by pressure differentials when sediment thicknesses are 305 m (1,000 ft) greater in one area than another, and Trusheim (1960) showed that in the German Zechstein basin an overburden of 1,000 m (3,281 ft) and a thickness of at least 300 m (984 ft) of salt were necessary to initiate flowage. Due to its density being less than the overlying sediment, the salt found weaknesses in the sediment and forced its way upward to form diapirs. Halbouty (1979) published one of the most comprehensive collections of information on salt domes and their formation.

As the salt mass forces its way up through the overlying sediment, it encounters a circulating water table. The evaporite mineral, anhydrite, is residual and was originally present in the salt. Being less soluble than salt, the anhydrite remains behind as the salt near the top or sides of the diapir dissolves. This residual anhydrite collects at the top of the dome to form cap rock. The cap rock grows from the top down; that is, anhydrite is added to the bottom of the cap as the salt is dissolved away. According to Feely and Kulp (1957) the thickness of the cap rock at any time depends upon the rate of movement of the salt, the rate of the flow of water across the salt, and the anhydrite content of the salt. Another theory is that the anhydrite caps may be exotic blocks of a sub-salt surface that were carried up with the salt.

At some point in its upward movement, the salt mass encounters hydrocarbon-bearing formations and petroleum is introduced to the cap rock. It is believed that the bacteria, *Desulfovibrio desulfricans*, causes a process of sulfate reduction on the anhydrite (calcium sulfate). Hydrogen sulfide gas (H_2S) is generated as one by-product of sulfate reduction. To prevent the flushing of H_2S, a sealing mechanism, known as false cap rock, must be present. False cap rock generally consists of impervious clays or shales overlying the cap rock. Although some elemental sulphur may be formed directly by the reduction of sulfate, much of the elemental sulphur is formed by the oxidation of hydrogen sulfide.

Other by-products from the reduction of sulfate in the anhydrite are calcite (calcium carbonate) and gypsum (hydrated calcium sulfate). Thus, those cap rocks that contain elemental sulphur consist of three parts: (1) the basal anydrite; (2) a transition zone containing gypsum, calcite, sulphur, and some accessory minerals; and (3) an overlying calcite zone. Not all salt domes have cap rocks nor do all cap rocks contain elemental sulphur.

From the previous discussion, it can be seen that a critical sequence of events must take place in order to form elemental sulphur in sufficient quantities for commercial mining. First, the moving salt must encounter a circulating water table. Next, the salt must be dissolved to form a residual cap rock of anhydrite. The cap rock must then encounter hydrocarbon zones in order to be exposed to the sulfate-reducing bacteria. Then, there must be an impervious barrier to trap the H_2S formed by sulfate reduction. And finally, the H_2S must be oxidized to form elemental sulphur.

Studies throughout the Gulf coast area of Texas and Louisiana have indicated that deposits of sulphur worthy of development have been found in a very small percentage of domes, and at depths generally not greater than 2,500 ft. Domes encountered at depths below 5,000 ft have little or no cap rock, ruling them out as possible sulphur sites.

The only quantitative method of determining the occurrence, distribution, and thickness of sulphur in cap rock is coring. Seismic methods can identify the presence of salt domes, but cannot reliably indicate the presence of cap rock. Domes having cap rock can be inferred by using gravity data, but the presence of sulphur can only be determined by drilling/coring.

b. Geologic Hazards

Within the Central Gulf, major geohazards to offshore development are associated with seafloor geologic features which result in seafloor instability. Primarily, the hazards are produced by: (1) increased gradient at the edge of the continental shelf where it merges with the continental slope; (2) regional high rates of deposition on the continental shelf that cause isostatic adjustments and deep-seated gravity faulting; (3) local high rates of unconsolidated sediments deposited on the increased gradient of the continental shelf edge that has led to intensive slumping and mudslides (particularly in the area of the Mississippi River Delta); (4) diapiric movement of low density material through overlying sediment that has caused extensive deformation, the damming of sediments, gravity faulting, and slumping; and (5) high biogenic gas content in rapidly deposited sediment. Since sulphur operations are by definition associated with diapirs, the hazards associated with diapirs would be most threatening to such activity. In addition to the faulting and deformation around diapirs, there is also the possibility of encountering shallow, high-pressure gas- or oil-bearing formations.

c. Non-Sulphur/Salt Mineral Resources

Besides sulphur, oil and gas, a couple minerals in the Central GOM are now, or have the potential to become, commercially exploitable. The State of Louisiana is currently assessing and mapping sand deposits for use in shoreline restoration. Most of these deposits occur in State waters; however, some potential deposits have been found in Federal waters. Deposits of quartz sand in Federal and State waters off the coasts of Mississippi and Alabama are of interest because of their potential use in the production of glass. None of the quartz sand deposits, however, are near any of the proposed bidding units in this proposed action.

2. Meteorological Conditions

The Central Gulf is influenced by a maritime subtropical climate controlled mainly by the clockwise wind circulation around a semipermanent area of high barometric pressure alternating between the Azores and Bermuda Islands. This circulation, around the western edge of the high pressure cell, aided by the trade winds, results in the predominance of moist easterly wind flow in this area. Another factor influencing the climate in the Western and Central Gulf is the persistence of high barometric pressure over the North American continent during the winter months, resulting in rare periods of relatively dry northerly wind flow over the Gulf (USDC, NOAA, 1972). Humidity, cloudiness, visibility, precipitation, and air temperatures over this portion of the Gulf are typical of a maritime climate and show little diurnal or seasonal variation. Average summer temperature is 29°C (84°F). Winter temperatures average 21°C (70°F). Rainfall averages between 102 cm at Galveston, Texas, and to 137 cm at New Orleans, Louisiana. Cloudiness and poor visibility are more pronounced in the winter season. Occasional dense sea fog may linger near the coast for several days. Dense, persistent fog is most frequent during late winter or early spring in the Mississippi River delta region because of the Mississippi River runoff reacting with the warmer Gulf waters. Tropical storms also effect this area and a hurricane can be expected at least once each two years (USDC, NOAA, 1978).

3. Physical Oceanography

The physical oceanography of the Central Gulf of Mexico has previously been described in Section III.A.3. of Final EIS 110/112. Recent descriptive information provided by oil companies operating in the area and simultaneous satellite observations indicate that the large warm-core eddies which separate from the Loop Current may substantially affect the currents along the upper slope, and perhaps also the outer shelf, offshore Louisiana. Anecdotal evidence includes strong east-northeastward trending currents at mid-depths along the margins of eddies. The frequency, duration, and intensity of these events is unknown. A physical measurement program, sponsored by the Minerals Management Service, began in the area in April 1987 and was designed to provide a more substantial data base for assessing the impact of this process.

4. Chemical Oceanography

The chemical oceanography of the Central Gulf has previously been described in Section III.A.4. of Final EIS 110/112. The Central Gulf of Mexico is strongly influenced by the presence of America's major river, the Mississippi, as well as a host of other major drainage systems. A complex geography of sounds and bays protected by barrier islands and extensive tidal marshes acts to delay mixing, resulting in extensive areas of mesohaline (middle salinity) conditions. Turbidity is normally quite high, with suspended sediments up to 1-10 mg/l, primarily composed of clay minerals. The salinity gradients established in estuarine areas are extremely important for maintenance of finfish and shellfish production, and enormous fluctuations in harvest may occur, paralleling annual hydrology.

In general, Louisiana's estuaries and near offshore waters are low in salinity and high in nutrient concentrations as compared with other states bordering the northern Gulf. These characteristics are due primarily to Louisiana's high rainfall and the large volume of river water which makes its way through rich alluvial soils to the Gulf of Mexico. The major contributors of nutrients to the estuaries are the Mississippi and Atchafalaya Rivers.

Within the nearshore area, sediment trace metal values may show high absolute concentrations or anomalous ratios due to the input of contaminated clays borne by the Mississippi. Transition metals known to be used/disposed of during heavy industrial processes, such as mercury and cadmium, are likely contaminants.

The Mississippi River input acts to create a lens of fresher, more turbid water, often curling to the west. Hydrographic studies, suspended sediment characteristics, and sensitive chemical analyses demonstrate its influence as far west as South Texas. Of importance is the water-column stratifying effect of this fresh lens on nearshore waters. It is frequently observed during summer months that anoxic bottom water conditions exist on the central Louisiana shelf. Mass mortality of organisms and characteristic chemical changes also occur. These conditions have serious implications for monitoring programs of any sort.

As a probable consequence of the large fluvial input of nutrients, the Louisiana nearshore shelf is considered one of the most productive areas of phytoplankton in the Gulf. Integrated chlorophyll values are two times average Gulf values, and integrated production values range an order of magnitude greater than the Gulf average.

Less is known about the nature of offshore waters in the central area than in other zones. Observations indicate that the effects of the Mississippi are felt here, although much reduced by distance. Anoxic bottom waters are not reported, although surface freshening occurs at times of maximal discharge. Upwelling of cooler, nutrient-rich waters onto the shelf is known, but the mechanism is not fully understood since regional circulation patterns remain unclear. The passage of detached, anticyclonic eddies toward the west may be important in this regard. The water column is frequently observed to contain turbid layers associated with interfaces between two or three distinct water layers. A Mississippian origin is suggested for these layers. It is believed that values for productivity and chlorophyll approach Gulf averages, but that circulation events, such as the transient effects of passing eddies, might play a role in enhancing these values.

5. Water Quality

Water quality is based upon numerous factors, including currents, freshwater inputs, nature and number of discharges, outfalls, and human activities that consist of municipal and industrial waste discharges, runoff, oil spillage, dredging, etc. In the past, water quality has been defined as the degree to which chemical concentrations and physical parameters within a water mass approach the ambient water state. Table III-1 illustrates the range of values for water quality parameters measured in the Gulf of Mexico off Texas and Louisiana. Offshore water quality degradation in the Gulf of Mexico is associated primarily with effluent discharges by current offshore enterprises, consisting of OCS activities and marine transportation sources. Historically, the highest concentration of oil and gas activity has taken place within an area south of Timbalier Bay, Louisiana, eastward to an area some 20 miles east of the Mississippi River Delta. This area extends offshore to the south for some 75 miles. Within this area, produced water discharges alone have ranged from 0.5 million to greater than 1.5 million gallons/square mile/year (USDC, NOAA, 1985). In the early 1960's, the Gulf of Mexico saw the first commercial offshore sulphur mining operation begin in State waters off Jefferson Parish, Louisiana, at the Grand Isle Mine. This was followed in 1968 by the

Table III-1

Range of General Water Quality Values for Offshore Freeport, Texas, and West Louisiana Coastal Waters

Parameters	Bryan Mound Predisposal Study[1]	SEADOCK (1973)[2]	West Louisiana Coast (1978-1979)
S ‰	16.1-36.9	15.1-33.6	--
T (°C)	10.5-31.5	11.1-30.6	--
pH	7.2-8.7	7.8-8.4	--
D.O. (mg/l)	1.1-10.3	0.2-101.9	--
O&G (mg/l)	< 0.5-23.4	< 0.3-2.6	--
TSS (mg/l)	< 0.1-264	5-85	--
NO_2-N (mg/l)	< 0.01-0.04	< 0.01-0.07	< 0.001-0.013
NO_3-N (mg/l)	< 0.01-0.67	< 0.01-0.14	< 0.001-0.15
NH_3-N (mg/l)	< 0.01-0.10	< 0.01-0.29	0.004-0.22
O-PO_4 (mg/l)	< 0.01-0.10	--	0.01-0.13
T-P (mg/l)	< 0.01-0.12	< 0.1-0.74	--
SiO_2 (mg/l)	< 0.05-4.2	--	0.17-2.4

Other Parameters[4]

Na	10,500 mg/l
K	380 mg/l
Ca	400 mg/l
Mg	1,350 mg/l
Cl	19,000 mg/l
I	0.06 mg/l
Br	65 mg/l

[1] Texas A&M Reserch Foundation, 1980.
[2] SEADOCK, 1975. (Eight stations nearest present study area.)
[3] Brooks, 1979.
[4] Riley and Skirrow, 1965.

Source: Texas A&M Research Foundation, 1980.

opening of a second operation on the Federal OCS at the Caminada Mine. At these two sites some 400 sulphur wells, 42 bleedwater wells, and 4 brine wells were drilled. From these wells it has been estimated that some 120,000 bbls of bleedwater were discharged per day into the offshore waters. To date, the Grand Isle Mine is operating; however, in March 1969, one year after its opening, the Caminada Mine was closed down. Coastal or onshore water quality varies and is determined by river outflows into the Gulf, primarily the Mississippi River. The Mississippi River has the greatest impact on the Gulf's water quality. Large amounts of turbidity and pollutants are introduced to Gulf of Mexico waters by the Mississippi River. The existing water quality of the coastal regions of the Gulf is briefly discussed below. For a more detailed discussion of water quality, see Volume 1, Section III.C.10. of the Final Regional EIS. See also Figure III-1 for areas of concern with respect to water pollution within the Central and Western Gulf coastal areas.

The Central Gulf of Mexico region is characterized by many water quality problems that are affected by the discharge or release of industrial wastes and domestic sewage into its rivers, bays, and estuaries. The most significant source of pollution in this area is the outflow from the Mississippi River which drains more than 5.5 million km^2 or 41% of the lands of the continental United States. This drainage results in the presence of high bacterial concentrations and toxic pollutants within the Mississippi River area and is evidenced by high levels of organic pollutants found in its deltaic sediments. Other contributions to water quality problems within this region stem from increased land clearing activities associated with agriculture, industry and urbanization, dredging and disposal of dredge material, and industrial/domestic pollution from numerous point source discharges along the coast. These activities have led to the eutrophication of several coastal water bodies in Louisiana and the permanent and temporary closures of many shellfisheries in the region.

6. Air Quality

Air quality of the coastal area along the Gulf of Mexico is measured against the NAAQS resulting from the Clean Air Act, as amended. These standards are designed to preserve the air quality of an area at a threshold necessary to protect public health and welfare.

The ambient air quality in any area is determined by utilizing special monitoring schemes (40 CFR 50) and is measured relative to NAAQS' primary and secondary standards. Primary standards are designed to protect public health, and secondary standards are designed to protect public welfare. If a county or section of a county does not meet the primary and/or secondary standards, they are classified as nonattainment. Areas designated as Prevention of Significant Deterioration (PSD) areas are identified as mandatory Class I Areas where visibility is an important value. These areas are national and international parks and wilderness areas.

The Central Gulf of Mexico is coastal in the states of Alabama, Louisiana, and Mississippi. Of the two Alabama counties fronting the Central Gulf, one is a clean air county. The other county exceeds primary standards for O_X. All three of the coastal counties in Mississippi are clean air counties. Of the 14 coastal parishes in Louisiana, 7 are clean air parishes. Seven parishes exceed primary standards for O_X.

In Louisiana there is one PSD Class I Area. All three states have State Implementation Plans for air quality, coupled with regulatory enforcement and monitoring programs in operation. The status of nonattainment and PSD Class I Areas are shown in Table III-2.

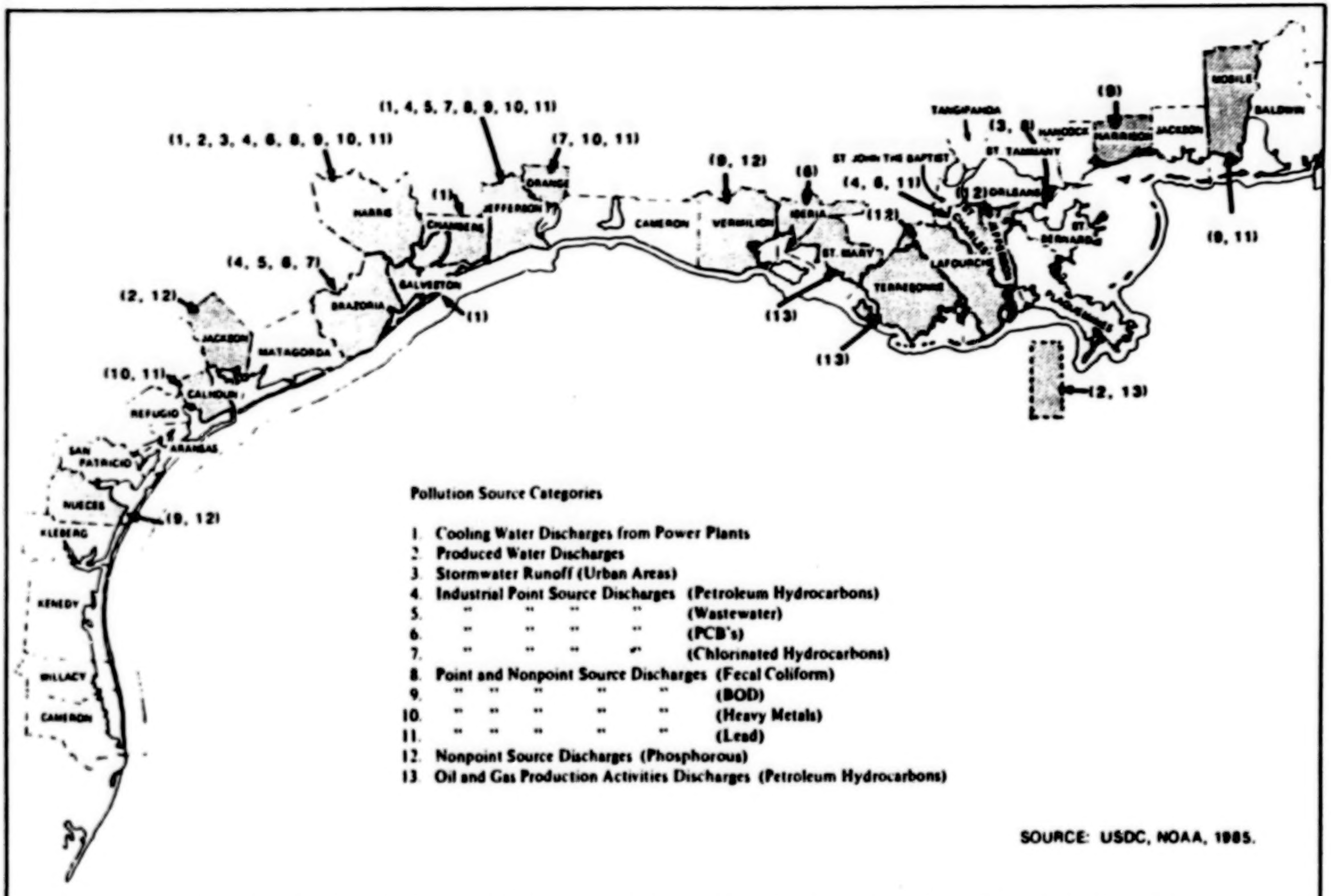
B. BIOLOGICAL RESOURCES

1. Coastal Habitats

a. Barrier Beaches/Islands

Barrier islands, spits, and bay barriers are subcategories of the overall geomorphic category called barrier beaches. Bay barriers are connected to headlands on both ends. Barrier spits are attached to a source of sediment but can be converted into islands by inlet severance of this connection. Barrier islands are bounded on each side by inlets without attachments to the mainland. In many cases a small barrier spit can develop on the flanks of a barrier island (Leatherman, 1982).

Barrier beaches (islands and spits) are a common landform along the Gulf Coast and stretch in an irregular chain from Florida to Texas as shown on Visual No. 4. These elongated, narrow landforms are composed of sand and



Pollution Source Categories

1. Cooling Water Discharges from Power Plants
2. Produced Water Discharges
3. Stormwater Runoff (Urban Areas)
4. Industrial Point Source Discharges (Petroleum Hydrocarbons)
5. " " " " (Wastewater)
6. " " " " (PCB's)
7. " " " " (Chlorinated Hydrocarbons)
8. Point and Nonpoint Source Discharges (Fecal Coliform)
9. " " " " " (BOD)
10. " " " " " (Heavy Metals)
11. " " " " " (Lead)
12. Nonpoint Source Discharges (Phosphorous)
13. Oil and Gas Production Activities Discharges (Petroleum Hydrocarbons)

SOURCE: USDC, NOAA, 1985.

Figure III-1. Areas of Concern with Respect to Point and Nonpoint Source Pollution Within the Central and Western Gulf of Mexico.

Table III-2

Nonattainment and PSD Class I Areas throughout the Gulf Coastal Region

Nonattainment Areas	TSP	SO_x	O_x	CO	NO_x
Central Gulf of Mexico					
Louisiana					
St. John the Baptist Parish			X		
Orleans Parish			X		
Jefferson Parish			X		
St. Bernard Parish			X		
St. Charles Parish			X		
Lafourche Parish			X		
St. Mary Parish			X		
Alabama					
Mobile County			X		

Note: X = Does not meet primary standards

PSD Class I Areas

Central Gulf of Mexico	
Louisiana	Breton Wilderness Area
Alabama	None
Mississippi	None

Source: 40 CFR 81.300.

other loose sediments transported by waves, currents, storm surges, and wind. In geological terms, barrier islands are a young phenomenon, being formed only in the last 5,000 to 6,000 years. The term "barrier" identifies the structure as one that protects other features, such as bays, estuaries, and marshes, from direct wave attack of the open ocean. The waters in these bays and estuaries are a blend of the terrestrial-freshwater systems of the mainland and the saltwater system of the ocean, and among the richest ecosystems known. Many of the species that inhabit the bays, estuaries, and adjacent marshes use these areas as spawning, nursery, and feeding grounds. It is estimated that "two thirds of the top-value Atlantic and Gulf Coast species of fish are directly dependent in some stages of life on conditions of these estuaries" (Clark, 1976).

Another benefit of both the islands and their adjacent marshes and bays is that of providing habitats for a large number of birds and other animals. The islands also provide habitat for several threatened or endangered species, for example, the loggerhead turtle, the southern bald eagle, alligators, and brown pelicans.

Barrier beaches are dynamic, relatively low land masses that often lead to conflict with human development. The shoreline is in constant flux, eroding or accreting in concert with changing energy conditions. These landforms tend to have a low elevation and are subject to saltwater flooding during major storm surges and elevated tides.

One of the characteristic features of barrier islands is their instability. Because the islands are composed of unconsolidated and shifting sands, they tend to migrate along the coast in response to littoral currents as well as a gradually rising sea level. The transient, migratory nature of the barrier island landform is essential to its role as the first line of defense of the mainland. The impact of storm waves and hurricane surges on the shore is greatly reduced by the barrier effect of these landforms. Many harbors and coastal communities along low-lying portions of the Gulf Coast owe their permanence to such protection.

The fact that barrier beaches (spits and islands) enclose estuaries and lagoons, which serve as the nursery ground for numerous marine species, makes these landforms especially important in maintaining the productivity of the coastal zone. Barrier changes, either natural or artificially induced, tend to affect the estuarine system performance. These closely related systems have evolved together and can withstand the dynamic nature of the oceanic environment, but are very susceptible to human disturbance.

Section III.B.1.a. of Final EIS 110/112 contains a detailed description of the morphology and sensitivity of the barrier beaches/islands located in the vicinity of the areas being offered for lease.

b. Wetlands

As depicted on Visual No. 4, the following wetland habitat types are characteristic of the central Gulf Coast: seagrass beds, mangroves, nonforested wetlands (tidal marshes), and forested wetlands (cypress-tupelogum swamps). The term nonforested wetlands collectively describes estuarine emergent wetlands (Cowardin et al., 1979). These include the fresh, brackish, and saline marshes, all of which are tidal. The tidal amplitude at any one point on the coast is usually less in the fresh marsh and greater in the saltmarsh. Marshes and mangroves form an interface between marine and terrestrial habitats, while seagrass beds occupy a transition zone between emergent vegetation and unvegetated estuarine and coastal bottoms. Forested wetlands are found inland from marsh areas. These habitats may occupy narrow bands or vast expanses and can consist of sharply delineated zones of different species, monotonous stands of a single species, or mixed plant species communities. The central origin of biologic productivity on the Gulf Coast are the vegetated estuarine habitats; primarily the mangroves, marshes, seagrass beds, and forested wetlands.

For a more detailed description of local differences and peculiarities in make up and variety, as well as acreage estimates and distributions of the various coastal habitat types, see Volume 1, Section III.B.1. of the Final Regional EIS and Visual No. 14 of the Final EIS for Sales 94/98/102 (USDI, MMS, 1984a).

Coastal wetlands are characterized by high organic productivity, high detritus production, and efficient nutrient recycling by retarding coastal erosion and land loss; and by providing habitats for a great number and wide variety of invertebrates, fish, herptiles, birds, and mammals.

Seagrass beds provide sediment stabilization, habitat diversity, nursery habitat for commercial and recreationally important species of fish and shellfish, and direct and indirect (detrital) food sources for many marine species (Palik and Kunneke, 1984).

Most of the coastal wetlands in the Gulf coastal plain are located in Louisiana, in association with the Mississippi River deltaic plain. This deltaic plain is characterized by cyclical episodes of delta growth, erosion, and environmental change. Wetlands in coastal Louisiana are usually established on a substrate of alluvial sediment that is subject to high, natural subsidence rates (Gagliano et al., 1981). The effects of natural subsidence are compounded by sea level rise, which has been occurring during the past several millennia. Under natural conditions, sedimentation encourages vertical accretion of wetland areas and may offset the submergence and inundation that result from subsidence and sea level rise.

During historic times, the natural deltaic processes and balance of sedimentation and submergence have been interrupted by extensive wetlands changes that have occurred in this century. These changes include shifts in wetland habitats and conversion of marsh to open water.

The deterioration of coastal wetlands in Louisiana is an issue of concern. It has been estimated that Louisiana is losing up to 50 square miles of wetlands every year. MMS is currently funding a study, "OCS Development and Potential Coastal Habitat Alteration," to examine wetlands loss. Additional discussions of wetlands loss are included in Section IV.C.1.a.(2).

The importance of the coastal wetlands to fish and wildlife resources is well-documented. FWS studies indicate that Louisiana contains 40% of the vegetated coastal wetlands in the conterminous United States and 64% of the tidal marshes along the Gulf of Mexico. The Louisiana coastal wetlands support over two-thirds of the Mississippi Flyway wintering waterfowl population (including 20%-25% of North America's puddle duck population) and the largest fur harvest in North America (from 40%-65% of the Nation's total per year) (Olds, 1984).

2. Offshore Habitats

All of the areas proposed for leasing are in the Central Gulf of Mexico. The offshore biological communities of concern are fully described in Section III.B.2. of Final EIS 110/112 (USDI, MMS, 1986), specifically pages III-24 through III-31. The locations of sensitive topographic banks are shown in Figure III-2. These features rise above the surrounding seafloor and support productive, diverse, and sensitive communities not found on the surrounding seafloor, which have historically been protected from offshore development by lease stipulations. None of the bidding units in this proposed action are near sensitive biological features.

3. Endangered and Threatened Species

Five Federally listed endangered whale species occur in the Gulf of Mexico. These include the fin, humpback, right, sei, and sperm whales. Usually, these large cetaceans inhabit the continental slope and deep oceanic waters; occasionally, they are sighted nearshore (Schmidly, 1981).

Endangered red wolf hybrids occur along the Gulf Coast in Cameron Parish, Louisiana and Jefferson County, Texas; pure-blood red wolves are extinct in the wild (McCarley and Carley, 1979).

Federally listed endangered sea turtles (Kemp's ridley, green, hawksbill, and leatherback turtles, and the threatened loggerhead turtle) occur in the Gulf of Mexico. The green turtle is listed as endangered in Florida waters and threatened throughout the rest of the Gulf of Mexico. The Kemp's ridley turtle inhabits shallow coastal and estuarine waters. Ridley turtles commonly occur in shallow water areas from Marsh Island to the Mississippi Delta in Louisiana (Hildebrand, 1982) and from Bolivar Roads to Sabine Pass in Texas. Kemp's ridley turtles infrequently nest on the beaches of southwestern Padre Island, Texas, where FWS, NMFS, and the National Park Service (NPS) have established a ridley turtle head start release program. The green turtle is found throughout the Gulf where its favored habitats are lagoons and shoals providing an abundance of marine grass and algae on which it feeds. No recent green turtle nesting has been reported along Gulf beaches. Juvenile green turtles occur in Texas estuaries (Hildebrand, 1982). The hawksbill turtle inhabits reefs, shallow coastal areas, and passes in water less than 20 m deep. No recent hawksbill nesting has been reported along the Gulf Coast. The leatherback turtle is the most pelagic marine turtle and may be found near the continental shelf edge. Sightings have been reported along the Gulf Coast in March and April; no recent nesting has been reported along the Gulf Coast. The loggerhead turtle occurs throughout the Gulf and has been observed as far as 500 miles out in the open sea. Some infrequent nesting occurs on the northern Gulf Coast. In addition to their usual habitat area, turtles are sometimes seen around offshore platforms. Visual No. 2 indicates the general locations of marine turtle nesting.

The American alligator occurs generally throughout the Gulf Coast region in fresh to brackish water areas. The alligator is listed as endangered throughout its range except in the coastal areas of Texas, Florida, and Louisiana where it is listed as "threatened by similarity of appearance."

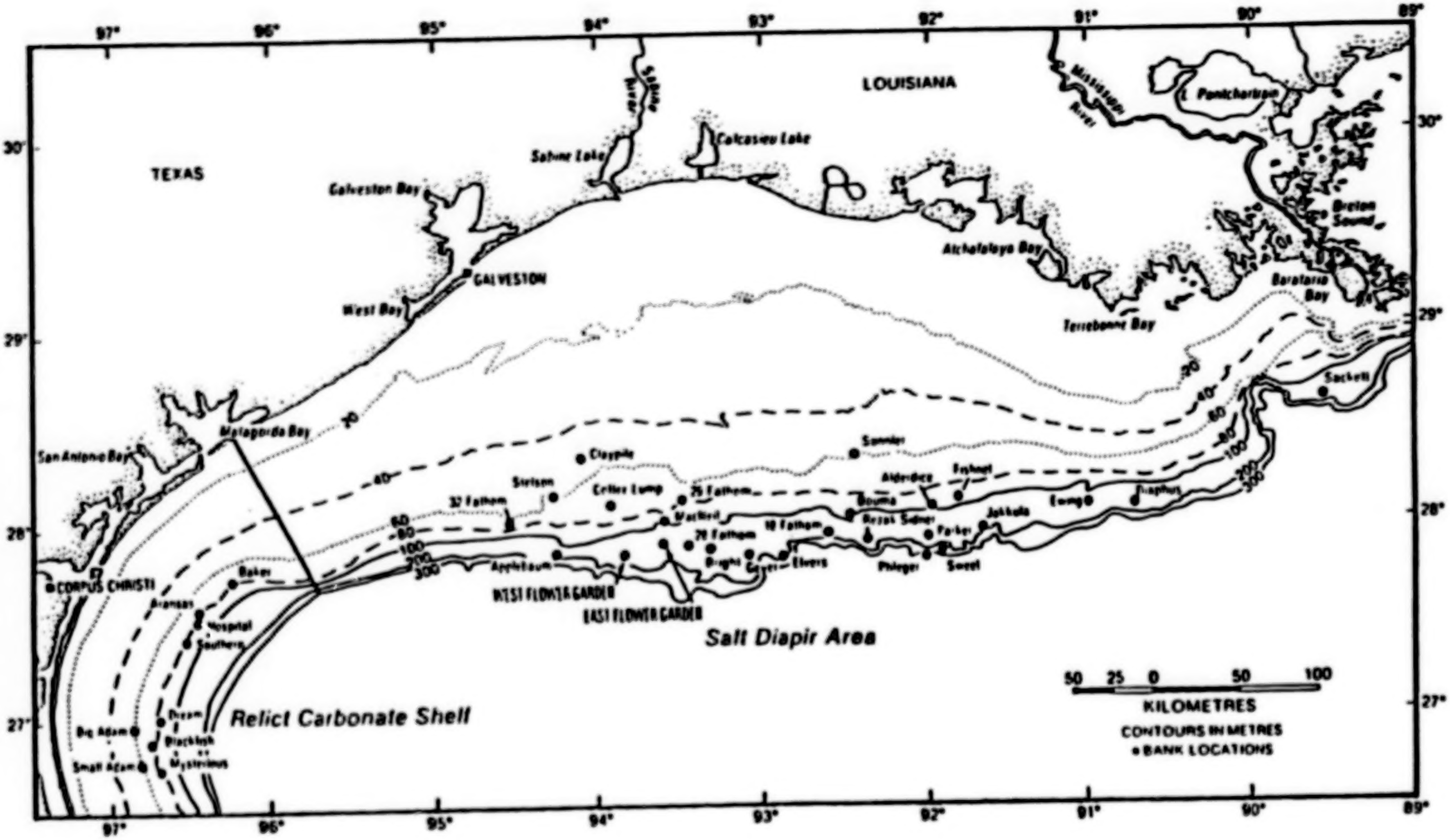


Figure III-2. Banks of the Northwestern Gulf of Mexico
(Source: Rezak et al., 1983).

The endangered red-cockaded woodpecker occurs primarily in mature open pine forests in the Central Gulf area and into eastern Texas.

Endangered American and threatened arctic peregrine falcons migrate along the Gulf Coast, and some peregrine falcons overwinter in Gulf coastal areas. The endangered piping plover's winter range is along the Gulf Coast.

Brown pelicans have been removed from the Federal endangered species list in Alabama and Florida but remain listed as endangered in Mississippi, Louisiana, and Texas. Three small brown pelican rookeries (about 2,500 birds) occur at North Island, northern St. Bernard Parish, and Queen Bess Island in Louisiana. The habitat of these colonial nesters are small coastal inlands in salt and brackish water areas as indicated on Visual No. 2. Endangered bald eagles inhabit several Gulf coastal counties.

4. Other Wildlife Species

a. Marine Mammals

About 28 species of marine mammals have been reported to occur in or migrate through the Gulf region (Schmidly, 1981). Those which occur in coastal waters are primarily small cetaceans (porpoises and dolphins), and occasionally large cetaceans (whales). All marine mammals are protected under the Marine Mammal Protection Act of 1972. The bottlenose dolphin is the most common small cetacean which occurs in bays, inland waterways, ship channels, and nearshore waters in the northern Gulf of Mexico. Surveys of the Louisiana-Mississippi coastal waters reported about 2,000-6,000 bottlenose dolphins (Leatherwood and Platter, 1975). Aerial surveys offshore Marsh Island, Louisiana, indicate about 1 dolphin/1.4 mi^2 (1 dolphin/3.7 km^2) (Fritts et al., 1983). Dolphins usually occur in herds of 3-7 animals, but large herds of 200-600 dolphins have been observed. Spotted, striped, and spinner dolphins are other small cetaceans which occur in the Gulf continental shelf waters. Short-finned pilot and pygmy sperm whales occur in the deeper Gulf slope and oceanic waters.

b. Coastal and Marine Birds

The beaches and coastal wetlands of the northern Gulf of Mexico region are inhabited by several migrant and nonmigrant coastal bird species, consisting primarily of three general groups: shorebirds, wading birds, and waterfowl. Feeding and nesting areas include beaches, coastal bays, and other coastal wetland areas. Reproductive activity for these groups occurs from February through August (Portnoy, 1977 and Clapp et al., 1982). Portnoy (1977) recorded 847,000 birds of 26 species in habitats ranging from swamp forest to coastal marshes and barrier islands in the Central Gulf area; the most abundant species were the Louisiana heron, snowy egret, and cattle egret.

The northern Gulf of Mexico coastal wetlands are the overwintering site for about 4-7 million migratory waterfowl (Bellrose, 1976). The peak of the fall migration is November-December and spring migration occurs from March to early May. The major waterfowl habitats are coastal bays and wetland areas. The national wildlife refuges and State wildlife management areas provide important feeding, nesting, and resting areas for many of these migratory waterfowl. Recreational hunting of waterfowl along the Gulf Coast is an important source of recreation and income.

Marine birds, such as gulls, terns, boobies, petrels, and shearwaters, occur in the Gulf continental shelf region (Murphy, 1967 and Clapp et al., 1982). Marine birds primarily feed and roost offshore, coming ashore for nesting or when storms blow them inshore. Generally, the largest concentrations of marine birds are found near upwelling areas (near the continental slope edge) and other areas of high productivity. Aerial surveys offshore Marsh Island, Louisiana, found 25 species of marine birds and 96% of all marine birds sighted were gull and tern species (Fritts et al., 1983).

5. Commercial Fisheries

Nearly all species significantly contributing to the Gulf's commercial catches are estuarine dependent. With the exception of such species as the oyster and spotted seatrout, most leave the estuaries as juveniles or subadults and spawn at sea after becoming reproductive adults. The eggs of the majority of these species hatch in the waters of the open Gulf, and the developing larvae become part of the offshore planktonic community. Under the influence of tides, currents, and winds, the young eventually arrive at the estuarine nursery grounds where they feed, grow, and mature prior to migrating out to sea to repeat the spawning process. This estuarine dependency is clearly shown in Table III-6 (Draft EIS 113/115/116) which contains species descriptions of the most economically important commercial fisheries species in the Gulf.

The egg and larval life stages of fisheries species are known to be sensitive to oil (Section IV.B.6.c. of Draft EIS 113/115/116). Figures III-6 through III-12 (Draft EIS 113/115/116) show the distribution of these life stages for the two most important commercial species in the Gulf, shrimp (*Penaeus* spp.) and gulf menhaden. Menhaden eggs are abundant over the continental shelf between Sabine Pass and Alabama from October-March, with high concentrations occurring near the Mississippi Delta. Penaeid shrimp larvae are widely distributed over the continental shelf of the northwestern Gulf with great seasonal and annual variations. Additionally, the larvae are distributed throughout the water column.

Characteristic fishes are associated with the various Gulf environments. The low salinity estuaries are generally dominated by finfishes such as croakers, spot, sand trout, anchovies, mullet and menhaden, and shellfishes such as oysters and crabs. The shallow Gulf (surf zone) characteristically contains such fishes as the Gulf whiting and Atlantic threadfin. The bottom becomes more muddy outside the surf zone, and fishes found here include the croaker, spot, star drum, silver trout, and longspine porgy. Farther offshore toward the middle shelf, the number of sciaenids (croaker family) is drastically reduced, and the fish community is dominated by small flounders and searobins. The offshore reefs support such fishes as snappers and seabasses, while oceanic fishes such as the bluefin tuna and broadbill swordfish inhabit the offshore open ocean waters (USDC, NMFS, 1979).

Darnell et al. (1983) and Darnell and Kleypas (in press) studied the distribution of demersal fish and penaeid shrimp over the continental shelf of the northern Gulf. They found that density distribution of total fish catch in the northwestern Gulf was highest nearshore off Louisiana (See back of Visual No. 2, Total Fish Catch [numerical abundance] Summer). For all seasons the greatest abundance occurred between Galveston Bay and the Mississippi River. The authors attributed this to the importance of low-salinity estuarine nursery areas (marshes) which are extensive along the Louisiana coast.

Nine species of penaeids contribute to the Gulf of Mexico shrimp fishery. Brown, white, and pink shrimp are the three most important commercial species. Brown shrimp are centered in the northwestern Gulf while white shrimp are centered on the mud and sand bottoms off the coast of Louisiana. (See Visual No. 2 for major finfish and shellfish harvest areas.) Pink shrimp have an almost continuous distribution throughout the Gulf, but consistent commercial pink shrimp catches are made on the shell, coral sand, and coral silt bottoms off southern Florida.

Gulf menhaden occur in the shallow waters of the northcentral Gulf from eastern Florida to eastern Texas with about 93% of this fishing effort occurring within 10 miles of shore. Also, the industrial bottomfish trawl fishery exists in the nearshore waters of the northcentral Gulf. Generally, the following fishes contribute 95%-98% of the trawl fishery catch: croaker, spot, sand seatrout, silver seatrout, silvereel, catfish, and longspine porgy. Croaker, the largest component of the catch, prefer a mud bottom and are generally not found at depths exceeding 60 fm.

Approximately 50 species of food finfish are harvested in the Gulf. Some of the more important include croaker, snappers, groupers, black mullet, red and black drum, spotted and silver seatrout, Spanish mackerel, spot, pompano, flounders, crevalle, Gulf kingfish, sheepshead, and king mackerel. The majority of food finfish are caught in coastal waters with the exception of such fishes as the snappers, groupers, mackerels, tunas, and billfish.

Mississippi produces large quantities of finfish and shellfish which results largely from the high productivity of the Mississippi Sound estuarine system, consisting of about 433,447 acres. It includes all the coastal waters of Mississippi and is bounded on the west by Lake Borgne, on the east by Mobile Bay, on the south by the Mississippi barrier islands, and on the north by the mark of ordinary high tide on the shore and to the extent of tidal influence in the riverine system (Mississippi Bureau of Marine Resources, 1981).

Approximately 5,000 acres of State-managed public oyster beds are located throughout the Sound. Mississippi's largest reefs lie off Pass Christian and in the western extreme of Mississippi Sound; however, other State oyster reefs and beds lie off Gulfport, Biloxi, and the Bangs Lake area.

Shrimp (primarily brown and white) represents the most important catch in Mississippi in terms of both quantity and value. Blue crab landings are also important and generally are about 2 million lbs/yr. In an effort to protect and enhance valuable fishery resources, the State Department of Wildlife Conservation, through the Bureau of Marine Resources, has established resource management sanctuaries for the shrimp and crab fisheries within waters under State jurisdiction. The shrimp management sanctuary can best be defined as consisting of those inshore estuarine waters within which commercial shrimping is forbidden. These shallow areas are essential for the growth and development of young commercially valuable shrimp and lie within one-half mile of the mainland from the

Mississippi/Alabama State boundary westward to Bayou Caddy in Hancock County and generally in all bayous and bays in the coastal area.

Female blue crabs in the egg-carrying condition (sponge crabs) are protected from harvest as they reach the waters of Mississippi Sound north of the barrier islands on their journey into deeper waters where they spawn. The specific sanctuary in which sponge crab harvesting is forbidden lies south of the Intracoastal Waterway out to three miles beyond the Mississippi barrier islands and from the Mississippi/Alabama boundary on the east to the Gulfport Ship Channel on the west.

The Gulf menhaden is the principal species of economic value in Mississippi's finfish catches. Many species of fish, including the Atlantic croaker, spot, and sand seatrout, are harvested by the industrial bottomfish fishery. However, nearly all are harvested from the offshore waters of the open Gulf beyond the State's seaward territorial boundary.

Commercial landings of food fish include numerous species such as croaker, flounder, black drum, and red snapper. These landings represent about 2% of the volume and 15.8% of the value of Mississippi's reported finfish landings (Mississippi Bureau of Marine Resources, 1981).

Louisiana is the most productive State in the Gulf in terms of commercial fisheries. This has been attributed to extensive coastal marshes and nutrient input from the Mississippi and Atchafalaya Rivers. Louisiana contains 64% of the tidal marshes along the Gulf.

In Louisiana, shrimp (primarily brown and white) constitutes the most important fishery. Production of shrimp in any particular year depends largely on environmental conditions in the estuaries during postlarval recruitment. Production is good when there is a warm, dry spring.

Menhaden are the basis of the State's largest fishery and rank second in value. Unlike the shrimp fishery, this fishery operates exclusively offshore.

Oyster constitutes the third most valuable fishery in Louisiana. The most important areas for oyster production are Terrebonne Parish, Barataria Bay, and the Lake Borgne-Breton Sound system. Oyster seed ground reservations are located in Caillou Lake (9,772 acres) in Terrebonne Parish, Hackberry Bay (4,015 acres) in Jefferson and Lafourche Parishes, Bay Gardene (2,666 acres) in Plaquemines Parish, and Bay Junop (2,448 acres) in Terrebonne Parish (Boudreaux, 1981). These areas are managed by the State for the taking of seed oysters. There are about 234,000 acres of private oyster leases in Louisiana that are concentrated in Plaquemines, St. Bernard, Terrebonne, Jefferson, and Lafourche Parishes. Public oyster grounds occupy approximately 690,000 acres, most of which are east of the Mississippi River (Groat, 1981).

The blue crab is the State's fourth most valuable commercial fishery species. Blue crabs spend the majority of their lives in estuarine waters which produce over 90% of the catch. Other important fisheries include the food finfish and those for industrial purposes, such as pet food.

C. SOCIOECONOMIC CONDITIONS AND OTHER CONSIDERATIONS

Although the proposed action is in the Central GOM, socioeconomic effects may be also felt in the Western GOM. The socioeconomic impact area comprises 39 counties and parishes. The coastal counties/parishes extend from Baldwin County in southeastern Alabama to Matagorda County in south central Texas. Inland counties/parishes are included where offshore minerals support activities are known to exist (such as Lafayette, Louisiana, and Wharton County, Texas); where offshore-related mineral industries are established (such as the Mississippi River region in Louisiana); and to account for all counties within Standard Metropolitan Statistical Areas' (SMSA) boundaries when one county is on the coast. The counties/parishes in this socioeconomic impact area are:

Central Gulf of Mexico

Alabama	-	Baldwin, Mobile
Mississippi	-	Hancock, Harrison, Jackson, Stone
Louisiana	-	Ascension, Calcasieu, Cameron, East Baton Rouge, Iberia, Jefferson, Lafayette, Lafourche, Livingston, Orleans, Plaquemines, St. Bernard, St. Charles, St. James, St. John the Baptist, St. Mary, St. Tammany, Terrebonne, Vermilion, West Baton Rouge

Western Gulf of Mexico
Texas - Brazoria, Chambers, Fort Bend, Galveston, Hardin, Harris, Jefferson, Liberty, Matagorda, Montgomery, Orange, Waller, Wharton

The Gulf region varies substantially in socioeconomic patterns ranging from low-density, undeveloped rural areas to high-density, highly developed urban centers. There are nine SMSA's in the region (in east to west order):

Central Gulf of Mexico
Alabama - Mobile
Mississippi - Pascagoula, Biloxi-Gulfport
Louisiana - New Orleans, Baton Rouge, Lafayette, Lake Charles

Western Gulf of Mexico
Texas - Beaumont-Port Arthur, Houston-Galveston-Brazoria

The most populated SMSA's across the three zones in the region are New Orleans and Houston. The least populated is Pascagoula.

The highest levels of employment by major industry group in each state's coastal region are in the areas of manufacturing, wholesale/retail trade, and services (including finance, insurance, and real estate (F.I.R.E.)). A summary of specific employment, income, and population characteristics is given below.

1. Employment

Table III-3 reflects the historic indicators for the labor force and unemployment in the Gulf region. In 1970, the regional unemployment rate (4.0%) was just below that of the United States (4.4%); in 1980, the regional rate (5.6%) was well below the comparable United States figure (7.1%); and in 1986, the regional rate (11.3%) was well above that of the United States (7.1%).

Central Gulf of Mexico

Labor force data for the three Central Gulf states are given in Table III-3. In both 1970 and 1980, all three states' coastal areas had unemployment rates above the regional average. In 1970, the Louisiana and Alabama coastal regions' unemployment rates were above the United States rate; while in 1980, the Mississippi and Alabama regions were above the United States rate. In 1986, the unemployment rates for Mississippi (9.6%) and Alabama (9.9%) were below that of the Gulf region (11.3%) yet above that of the United States (7.1%). The unemployment rate for Louisiana (12.6%) was above that of the Gulf region (11.3%) and that of the United States (7.1%).

Employment by major industry group for Alabama is shown in Table III-4. In 1984, the highest levels were recorded in the sectors of services, trade, and manufacturing in order of magnitude for the coastal region. Mobile County accounts for over 85% of all employment in the Mobile SMSA. Between 1970 and 1984, wholesale and retail trade has continued to increase in relative share of the labor force.

Table III-4 also provides employment by major industry group in the Mississippi coastal region. In order of magnitude, the leading sectors in 1984 were manufacturing, trade, and services. Manufacturing was centered primarily in Jackson County (Pascagoula SMSA), while trade and services were concentrated in Harrison County (Biloxi-Gulfport SMSA).

Employment by major industry group for the Louisiana coastal region is also shown in Table III-4. Leading sectors, in order of magnitude, were services, trade, and manufacturing. Manufacturing was far lower in relative share of the labor market in Louisiana than in any other state in the Gulf region. Employment in the leading sectors was concentrated in Orleans and Jefferson Parishes of the New Orleans SMSA, and East Baton Rouge Parish of the East Baton Rouge SMSA.

Table III-3

Labor Force Data
Gulf of Mexico Region*

	Labor Force (000)			Unemployment Rate (%)		
	1970	1980	1986	1970	1980	1986
Alabama	133.8	183.1	212.2	5.3	7.5	9.9
Mississippi	78.9	108.1	147.1	4.3	7.7	9.6
Louisiana	742.6	1,081.3	1,222.9	4.9	5.9	12.6
Texas	1,235.3	2,032.7	2,019.9	3.5	5.0	10.7
Gulf Region	3,267.0	5,334.9	3,602.1	4.0	5.6	11.3
United States	82,700.0	106,821.0	117,815.0	4.4	7.1	7.1

*Data shown for each state are for those counties/parishes in the socioeconomic impact area.

Sources: Alabama Department of Industrial Relations, Research, and Statistics, 1987.
Labor Force Estimates for Texas Counties, 1980 and 1987.
Labor Market Information, 1980 and 1987.
Labor Market Trends, 1980 and 1987.
USDC, Bureau of the Census, 1986.
USDC, Bureau of Economic Analysis, 1983 and 1987.
U.S. Dept. of Labor, Bureau of Labor Statistics, 1986.

Table III-4

Employment by Major Industry Group*
Central Gulf of Mexico - 1984 Percent of Total

	Alabama Coastal		Mississippi Coastal		Louisiana Coastal	
	Area	State	Area	State	Area	State
Agriculture, Forestry, Fishing	0.46	0.41	0.33	0.57	0.32	0.41
Mining**	0.77	1.29	0.56	1.29	6.87	6.39
Contract Construction	9.02	6.21	4.79	5.48	8.28	8.29
Manufacturing	18.39	29.94	28.00	32.74	11.81	14.01
Transportation, Communications, Utilities	6.74	6.12	5.91	5.34	9.51	8.36
Wholesale, Retail Trade	30.82	25.00	26.80	26.41	29.41	29.42
Services, including F.I.R.E.	31.65	25.43	23.33	24.02	31.53	30.46
Government	2.15	5.59	10.28	4.15	2.27	2.66

*Totals of industry percentages may not equal 100 due to rounding.
**With the exception of mining, coastal area totals do not include data reported as statewide. For mining, a percentage of the data reported as statewide is included in the total (Alabama, 40%; Mississippi, 15%; and Louisiana, 65%).

Source: USDC, Bureau of the Census, 1986.

Table III-5

Employment by Major Industry Group*
Western Gulf of Mexico - 1984 Percent of Total

	Texas Coastal Area	State (Texas)
Agriculture, Forestry, Fishing	0.56	0.49
Mining**	1.97	4.49
Contract Construction	9.25	8.38
Manufacturing	16.46	17.98
Transportation, Communications, Utilities	7.56	6.32
Wholesale, Retail Trade	27.89	28.99
Services, including F.I.R.E.	31.77	30.17
Government	1.58	3.17

*Totals of industry percentages may not equal 100 due to rounding.
**With the exception of mining, coastal area totals do not include data reported as statewide. For mining, 40% of data reported as statewide is included in the total.

Source: USDC, Bureau of the Census, 1986.

Western Gulf of Mexico

Labor force data for the Texas coastal area is shown in Table III-3. In both 1970 and 1980, the unemployment rate for this coastal zone was below that of the aggregate Gulf region and the United States rates. In 1985, the Texas unemployment rate (10.7%) was below that of the Gulf region (11.3%) and above that of the United States (7.1%).

Table III-5 gives the breakdown of employment by major industry groups. Leading sectors, in order of magnitude, were services, trade, and manufacturing. In 1984, this employment was highly concentrated in Harris County (Houston-Galveston-Brazoria SMSA) and in Jefferson County (Beaumont-Port Arthur SMSA).

2. Income

Total and per capita personal income for the Gulf region are shown in Table III-6. The per capita personal income for the region ($3,600) was 92% of the United States level ($3,900) in 1970. In 1978, the Gulf region and United States figures were equal ($7,900). In 1984, per capita personal income for the Gulf region ($12,800) was the same as the United States level ($12,800).

Central Gulf of Mexico

Alabama and Mississippi historically have poor personal income indicators. In 1970, the per capita income of these states was 83% and 89% ($3,000 and $3,200) of the Gulf region value ($3,600) and 85% and 90% of the national level ($3,900), respectively. In 1978, Alabama's per capita income had risen above that of Mississippi's, yet both states had dropped to 80% and 77% ($6,300 and $6,100) of both the Gulf region ($7,900) and United States per capita income levels ($7,900), respectively.

The per capita income of Alabama in 1984 was 77% of the Gulf region and the United States ($12,800); while the per capita income of Mississippi in 1984 ($9,100) was 71% of the Gulf region and the United States. In 1970, the per capita personal income of Louisiana ($3,300) was 92% of that for the Gulf region ($3,600) and 84% of that for the United States ($3,900). In 1978, the per capita personal income for Louisiana ($7,500) was 94% of that for the Gulf region and the United States. In 1984, the figure for Louisiana ($12,000) was 94% of the region's figure and the United States figure.

Western Gulf of Mexico

Texas' Gulf region achieved the largest per capita personal income in the coastal region. In 1984, the Texas coastal zone per capita income level ($14,100) was approximately 10% above that of the Gulf region. In 1970, 1978, and 1984, the Texas coastal region equalled or surpassed the United States per capita income level.

3. Population

Table III-7 shows population changes in the Gulf region for 1970, 1980, and 1984, when growth over this period was substantial. All states experienced growth rates well above the 1980-1982 period.

Central Gulf of Mexico

In Alabama the average annual growth rate (1.7%) was almost half that of the Gulf region, as was the rate for Louisiana (1.7%). Mississippi's growth rate (2.4%) was slightly higher, however.

Western Gulf of Mexico

In Texas there is a 3.9% average annual growth rate, which is well above that of the Gulf region and is the highest of all the states in the analysis area.

Table III-6

Income Data of Coastal Counties in the Gulf of Mexico Region

	Per Capita Personal Income (Thousand $)				Total Personal Income (Billion $)			
Area	1970	1978	1984	%Change 1978-1984	1970	1978	1984	% Change 1978-1984
Alabama	3.0	6.3	9.8	55.4	1.1	2.8	4.6	62.8
Mississippi	3.2	6.1	9.1	48.6	0.8	1.8	3.0	66.7
Louisiana	3.3	7.5	12.0	59.6	7.0	17.5	31.6	80.5
Texas	3.9	8.7	14.1	61.8	12.0	33.5	57.1	70.4
Gulf Region	3.6	8.0	12.8	60.0	20.9	55.6	96.3	73.2
United States	3.9	7.9	12.8	61.7	801.0	1,717.0	3,016.3	75.7

Sources: USDC, Bureau of Economic Analysis, 1977; 1980.
USDC, Bureau of Economic Analysis, 1986.

Table III-7

Population Data of Coastal Counties in the Gulf of Mexico Region*

(thousands)

Area	1970	1980	1984	% Change 1970-1984	Average Annual Growth Rate 1970-1984
Alabama	376.7	443.5	465.7	23.6	1.7
Mississippi	248.0	309.9	331.1	33.5	2.4
Louisiana	2,141.9	2,477.9	2,638.1	23.2	1.7
Texas	3,104.4	4,286.5	4,056.2	30.7	2.2
Gulf Region	5,871.0	7,517.8	7,491.1	27.6	2.0
United States	20,3312.0	226,504.8	236,166.4	16.2	1.2

*Derived from total personal income and per capita income data.

Sources:
Environmental Consultants, Inc., 1974.
USDC, Bureau of the Census, 1982.
USDC, Bureau of Economic Analysis, 1986.

4. Coastal Management Programs

The Gulf of Mexico OCS Region is made up of five coastal states. Four of the five states have Federally approved coastal management programs (CMP). The fifth state, Texas, conducts coastal management affairs independent of the Federally sponsored coastal zone management planning program. The three CPA State programs are briefly described below.

Alabama Coastal Area Management Plan (ACAMP)

The Alabama Coastal Area Act (ACAA) of 1976, as amended in 1982 by the Alabama Environmental Management Act (AEMA), divides implementation of coastal resource management between two State agencies: the Department of Environmental Management (DEM) and the Department of Economic and Community Affairs (DECA). The AACA and AEMA provide statutory authority to DEM to review all uses which have a direct and significant effect on the coastal area and require a State permit. DEM's permitting authority must be consistent with approved State policies, rules, and regulations. All coastal area program planning policy formulation, coordination, and resource research and study are performed by DECA. Both permitting and planning functions were formerly conducted by the Coastal Area Board until legislative amendments dissolved the Board and reassigned responsibilities in 1982.

Mississippi Coastal Program

The Mississippi Coastal Program (MCP) is administered by the Mississippi Commission on Wildlife Conservation through the Bureau of Marine Resources (BMR). The primary coastal management statute is the Coastal Wildlife Protection Law (Mississippi Code, Section 49-27-1). The authorities of certain other agencies are incorporated into the MCP pursuant to the Mississippi Code (Section 57-16-6) which requires the coastal program to incorporate "all of coastal Mississippi." BMR, the Bureau of Pollution Control, the Bureau of Land and Water Resources, and the Department of Archives and History are identified collectively as the "coastal program agencies." The Mississippi Commission on Wildlife Conservation, acting through BMR, consolidates authorities previously assigned to the Marine Resources Council and the Marine Conservation Commission, including authority to study and develop plans, proposals, reports, and recommendations for the development and utilization of the coastal offshore lands, waters, and marine resources of the state. Additional statutory authorities supporting MCP are listed in Tables III-11 and III-12 of Final EIS 94/98/102.

Louisiana Coastal Resources Program

The basis for the Louisiana Coastal Resources Program (LCRP) is Act 361, the State and Local Coastal Resources Management Act of 1978 (La R.S. 49:213.1). The Act puts into effect a set of State coastal policies and coastal use guidelines that apply to coastal land and water use decisionmaking. A number of existing State regulations are also incorporated into the program, including those concerned with oil and gas and other mineral operations; leasing of State lands for mineral operations and other purposes; waterbottom pipelines; hazardous waste and radioactive materials; management of wildlife, fish, other aquatic life, and oyster beds; endangered species; LOOP; and air and water quality.

The Act also authorized establishment of Special Management Areas (SMA's). Included or planned to be included as SMA's are LOOP, Marsh Island, artificial barrier islands to protect deteriorating coastal areas, and freshwater and sediment diversion projects to offset land loss and saltwater encroachment.

The coastal use guidelines are based on seven general policies outlined in Act 361. They are implemented through coastal use permits and in-lieu permits. In-lieu permits provide for the use of permit requirements existing before the Act took effect to fulfill the role of coastal use permits, thereby avoiding duplicative permitting procedures.

5. Oil and Gas Industry

The infrastructure for oil and gas production in the Gulf of Mexico is the most developed in the world. It includes oil refineries, petrochemical and gas processing plants, supply bases for offshore services, platform construction yards, pipeline yards, and other industry-related installations. This infrastructure is highly concentrated in the coastal areas of Louisiana and eastern Texas, and to a lesser extent, along the southern half of the Texas Gulf Coast and east of Louisiana as far as Mobile, Alabama.

The Gulf of Mexico offshore oil and gas industry has experienced dramatic changes over recent years. Federal offshore mobile rig demand decreased significantly between the end of 1981 and mid-1983. In the midst of this decline, however, industry continued to expand its capacity in response to earlier years of growth. In mid-1983, the Federal Government's institution of its areawide offshore leasing program provided a significant boost to the declining oil and gas industry. The total amount of leased OCS acreage jumped from 11.7 million acres in the second quarter of 1983 to 19 million acres in the fourth quarter of 1984. Offshore rig utilization increased dramatically from mid-1983 through the fourth quarter of 1984. This renewed interest was short-lived for by the first quarter of 1985, the recognition of a continued excess supply of oil and gas worldwide halted the growth of offshore drilling activity in the Gulf of Mexico. Wellhead prices of oil and gas showed a declining trend throughout 1985 before plummeting to approximately 50% of the 1985 year-end prices by the second quarter of 1986. Despite continued offshore Federal areawide lease sales in the Gulf of Mexico, offshore drilling has decreased drastically since 1985. As of February 1987, there is a total of 21.5 million acres under lease, and, of this total, 6.8 million acres are producing.

In summary, the current situation is an offshore sector which has a significant idle capacity of equipment and labor. This idle capacity and low levels of drilling are expected to continue until the wellhead price of oil and gas reaches a higher level.

OCS oil and gas activity contributes significantly to the economies of the Gulf of Mexico coastal region, both directly and indirectly. OCS oil and condensate production in Louisiana and Texas peaked in 1972 at 389.3 million barrels while their production value reached its highest level of $10.2 billion in 1984. Natural gas production in Louisiana and Texas OCS waters reached its highest level in 1981 at 4,836.8 billion cubic feet. The value of natural gas production in these areas peaked in 1984 at $12.7 billion. Both the volume and value of gas production have declined in 1985 and 1986. Job estimates as of June 1986 show that 76,600 jobs are directly or indirectly dependent on the offshore program. Approximately 61,300 of these jobs are associated with activity in the Central Gulf and 15,300 are related to the Western Gulf. The average annual payroll associated with this employment amounts to approximately $1.9 billion. Average annual State and local taxes generated by the OCS activity total about $148.7 million.

These June 1986 conditions represent a 38% decline in the oil and gas industry from the previous peak which occurred in December 1984. From an employment standpoint, the Gulf of Mexico coastal region has suffered considerable losses. This, in turn, has affected the amount of tax revenue generated in the study area. Currently, there is little information available which quantifies impacts related to the decline of the oil and gas industry on the economy as a whole. However, MMS is currently in the process of collecting information on depressed local economic conditions in the Gulf of Mexico OCS region. Both in-house and contract studies are forthcoming. For more information relating to this discussion of the Federal offshore oil and gas industry, see Section III.C.5. of Final EIS 110/112..

6. Sulphur Industry

The sulphur industry has been well established along the Louisiana and Texas Gulf coast since the 1920's. The Frasch-mining process (Appendix B) was developed to mine sulphur from the cap rock of salt domes in the area.

In 1984, the most recent year for which U.S. Dept. of Commerce data is available, employment in the Louisiana and Texas coastal regions in the sulphur mining industry was 350 and 375 people, respectively. This employment was specifically concentrated in Jefferson and Plaquemines Parishes (Louisiana) and Wharton County (Texas). Based on unpublished in-house MMS analysis, it is estimated that in addition to this direct employment of 725 people in sulphur mining, there were about 4,000 jobs indirectly related to sulphur mining in the coastal region. About 70% of these indirect employment opportunities were in the manufacturing sector, particularly relating to industrial inorganic chemicals. The remaining indirect employment, i.e., 30% of the total, represents jobs in trade and services sectors which result from the mining and manufactoring employment more specifically related to sulphur operations. The total estimated payroll associated with these direct and indirect jobs was about $130 million. While these total employment and payroll effects represent less than one-tenth of 1% of total employment and income from all sources in the coastal area in 1984, their existence has been important from an economic standpoint at the local level, particularly in recent times of declining oil- and gas-related job opportunities in those same communities.

Regarding local mining operations, two offshore mines, both operated by Freeport McMoran, are in existence off Jefferson Parish, Louisiana (Appendix C). The Grand Isle Mine, in State waters, went into production in 1960 and is still producing. The Caminada Mine, in Federal waters, was in production for one year in 1968 and then was closed. The Caminada Mine is currently being reactivated and production is scheduled to begin in 1988. Current production at the Grand Isle Mine averages around 700,000 tons per year. Caminada Mine, in the year that it was in production, produced around 325,000 tons of sulphur.

In support of the two offshore mines, Freeport McMoran operates a shore support base located on the eastern end of Grand Isle, Louisiana. Production from the Grand Isle Mine is pipelined to the Grand Isle facility where it is transferred to insulated barges for transportation to the shipping and processing terminal at Port Sulphur, Louisiana. Production from the Caminada Mine will be barged to shore.

Freeport currently employs about 7 people at the Grand Isle shorebase, some 130 Freeport employees and another 75-80 contract personnel at the Grand Isle Mine, and about 60 permanent employees with another 20 contract support personnel at the Port Sulphur terminal. Transportation of Freeport's sulphur provides employment for about 15 people (operating the tow boats) and another 15-20 are employed for maintenance and support (Mickleberry, 1986, personal communication).

Two onshore mines, Garden Island Bay located off South Pass in the Mississippi River Delta and operated by Freeport, and Boling Dome, located at Newgulf, Texas, and operated by Texasgulf Chemicals, are also actively producing sulphur from salt dome cap rocks. Production from the Garden Island Bay Mine is transported by barge to the Port Sulphur, Louisiana, terminal; production from Boling Dome is transported by rail tanker car to a shipment facility located in Beaumont, Texas.

Much of Freeport's sulphur is shipped up the Mississippi River to processing facilities in Louisiana or to Tampa, Florida, for use in the fertilizer industry. Most of Texasgulf's sulphur production is shipped by water to their fertilizer operation located in North Carolina.

In addition to Frasch-mining of caprock, sulphur is available from a number of alternative sources. Native sulphur also occurs in bedded anhydrite-gypsum evaporite basin formations and in unconsolidated volcanic deposits. Sulphur is mined from evaporites in west Texas, Poland, the U.S.S.R., and Iraq. Volcanic sulphur occurs mostly in the circum-Pacific belt, but furnishes only a minor portion of the world supply (Morse, 1985). Sulphur is also recovered from various non-elemental forms:

Natural Gas - Hydrogen sulfide occurs as a component of natural gas in many parts of the world. To market this "sour" natural gas, the hydrogen sulfide must be removed and consequently, as additional sour natural gas fields have been brought into production, elemental sulphur recovered from these fields has become a major world supply. Major deposits of sour natural gas occur in western Canada, the Near East, and the U.S.S.R.; substantial deposits occur in the mountain and gulf coast regions of the United States, in Mexico, France, the Federal Republic of Germany, and Venezuela (Morse, 1985). In the Central Gulf of Mexico region, refineries in Lake Charles, Louisiana; Westlake, Louisiana; Baton Rouge, Louisiana; Chalmette, Louisiana; Meraux, Louisiana; Convent, Louisiana; Pascagoula, Mississippi; and the Mobile, Alabama, area produce around 1,985 tons of sulphur per day from sour natural gas and crude oil (Cantrell, 1986).

Sulfide Deposits - These include deposits of (1) ferrous sulfides (pyrite, marcasite, and pyrrhotite) that, while they may contain minor quantities of nonferrous metals, are generally mined and processed for their sulphur content and (2) nonferrous metal sulfides, which are mined and processed for their metal content and in processing produce sulphur in the form of sulfuric acid. Sulfide minerals of copper, lead, zinc, molybdenum, nickel, mercury, arsenic, antimony and silver are the most noted in the nonferrous sulfide group (Morse, 1985).

Sulfate Deposits - These include bedded deposits of anhydrite and gypsum. Although they are mined on a large scale world wide for their mineral content, they represent one of the world's largest-yet virtually untapped sulphur resource. Existing technology can recover elemental sulphur from these sources, but the economics are presently unfavorable (Morse, 1985).

Petroleum and Tar Sands - Complex organic sulphur compounds occur as a component of petroleum and tar sands in a wide range of concentrations. In the refining of petroleum or bitumen from tar sands, a portion of the sulphur is removed and recovered in the elemental form. Because of environmental concerns, the portion of contained sulphur removed continues to increase annually. The vast petroleum reserves of the Near East contain high percentages of sulphur; as do many of the recent discoveries in Mexico and the U.S. west coast. Additionally, Canadian tar sands constitute a major sulphur source (Morse, 1985).

Coal and Oil Shale - Sulphur occurs as pyrites or complex organosulphur compounds in varying concentrations in both coal and oil shales. Although little sulphur is produced from these sources at present, the potential for large-scale output exists in the United States and the rest of the world.

7. Ports and Marine Transportation

Shipping patterns in the Gulf of Mexico have developed over the years in relation to the locations of the major Gulf Coast ports and the two Gulf access routes: the Straits of Florida and the Straits of Yucatan. Each year, thousands of trips are made through these waters by vessels involved in waterborne commerce, commercial and recreational fisheries, and offshore minerals resource exploration, development, and production. The extent and diversity of these activities plus the introduction of fixed structures for resource development and production has resulted in occasional multiple-use conflicts. The key factors in the mitigation of these conflicts are safety fairways and requirements for proper lighting and marking of structures (Section III.C. 6. of Final EIS 110/112).

Existing offshore sulphur production structures are not considered an unreasonable impediment to navigation. Any new structures resulting from the proposed action will be situated outside of fairways and will adhere to all safety requirements. Vessels servicing existing locations currently operate out of the ports of Grand Isle, Beaumont, and Galveston. Indications are that any new production facilities resulting from the proposed action will be serviced from the same ports. No new onshore facilities are expected.

8. Commercial Fishing Industry

The Gulf of Mexico is the single most important area for fisheries production in the United States. (See Visual No. 2 for major harvest areas.) In 1985, the total landings of all fisheries in the Gulf was about 2.4 billion pounds, valued at $596 million dockside, and represented about 38% of the total United States landings by pounds and 26% by value (USDC, NMFS, 1986b). Major Gulf fisheries landings ports and statistics for 1982-1985 are listed in Table III-13 of Draft EIS 113/115/116. In 1985, the top four U.S. ports in quantity of commercial fishery landings were Cameron, Louisiana; Pascagoula-Moss Point, Mississippi; and Dulac-Chauvin and Empire-Venice, Louisiana.

The Gulf shrimp fishery represents the single most valuable fishery in the United States with landings (heads removed) averaging approximately 230 million lbs/yr (Table III-14, of Draft EIS 113/115/116). The major shrimp species include brown, white, and pink shrimp. In 1981 production reached almost 270 million pounds worth over $401 million dockside. In addition to shrimp, the blue crab significantly contributes to the Gulf's crustacean landings. In 1985, about 56 million pounds of blue crabs, worth about $16 million, were taken in the Gulf's nearshore estuaries and sounds (USDC, NMFS, 1986b). Oysters are the main mollusc harvested in the Gulf's nearshore estuaries and sounds, and oyster landings in 1985 were approximately 26.5 million lbs valued at about $41 million (USDC, NMFS, 1986c, personal communication).

In the Gulf the following commercial fishes were the most economically important in 1985 and are arranged in order of decreasing priority: gulf menhaden, groupers and scamp, red snapper, black mullet, red drum, yellowfin tuna, catfish and bullheads, swordfish, black drum, spotted seatrout, yellowtail snapper, pompano, vermilion snapper, and king mackerel and cero (USDC, NMFS, 1986c, personal communication).

The menhaden purse seine fishery is the most important fishery in terms of pounds landed. In 1985, 1.9 billion pounds valued at $67 million were landed in the Gulf (USDC, NMFS, 1986b). Menhaden are used in the manufacture of fish meal and solubles for additives to livestock feeds, and production of fish oil. Also, small amounts are used for bait and canned pet food.

The industrial bottomfish trawl fishery produces stock for the pet food industry, bait, animal food, and fishmeal. This fishery reached peak production in the early 1970's at about 115 million pounds, worth about $2.8 million; however, it has declined in recent years.

In 1977, there were 29,296 fishermen operating 16,301 crafts of various sizes in the Gulf region (USDC, NMFS, 1984). This represented about 16% of comparable United States employment and vessels. In 1984, there were 917 processing and wholesale plants in the same area that employed over 14,744 people (USDC, NMFS, 1986b). Processed fishery products are produced in every state of the Gulf region. The Gulf region's processed fishery products amounted to about $737.8 million in 1977 and represented about 19% of the comparable United States total (USDC, NMFS, 1984). About 74% of the value of processed products for the Gulf region was related to shrimp production; menhaden ranked second with about 9%. About 71% of all Gulf processing involved frozen packaged items followed by canned items at 10%, industrial products at 9.6%, and fresh products at 9.2%.

Mississippi

Table III-8 contains 1985 commercial landings data in order of decreasing value for Louisiana. Shrimp is by far the most valuable component of the landings. In 1985, the total commercial landings for Mississippi were about 471 million pounds, worth about $40 million (USDC, NMFS, 1986a). Table III-9 contains the commercial catch for Mississippi Sound.

In 1977, there were approximately 2,483 commercial fishermen on the Mississippi coast where processed fishery products amounted to $108.7 million (USDC, NMFS, 1984). The main processed fishery products were shrimp, menhaden, oysters, and crabs.

Louisiana

Table III-8 contains 1985 commercial landings data in order of decreasing value for Louisiana. Shrimp is by far the most valuable component of the landings The menhaden fishery is the largest in terms of pounds landed. In 1985, the total commercial landings for Louisiana were about 1.7 billion pounds, worth $229 million (USDC, NMFS, 1986b). Louisiana ranked first in the United States in pounds landed and second in value. Table III-9 contains commercial catch for bays, and sounds along the Louisiana coast.

In 1977, there were approximately 12,092 commercial fishermen on the Louisiana coast where processed fishery products amounted to about $198.7 million. The main processed fishery products were shrimp, menhaden, oysters, and crabs (USDC, NMFS, 1984).

9. Recreational Activities

The northern Gulf of Mexico coastal zone is one of the major recreational regions of the United States, particularly in connection with marine fishing and beach-related activities. The shorefronts along the Gulf coasts of, Alabama, Mississippi, Louisiana, and Texas offer a diversity of natural and developed landscapes and seascapes. The coastal beaches, barrier islands, estuarine bays and sounds, river deltas, and tidal marshes are extensively and intensively utilized for recreational activity by residents of the Gulf south and tourists from throughout the Nation, as well as from foreign countries. Publicly-owned and administered areas such as National seashores, parks, beaches, and wildlife lands, as well as specially designated preservation areas such as historic and natural sites and landmarks, wilderness areas, wildlife sanctuaries, and scenic rivers attract residents and visitors throughout the year. Commercial and private recreational facilities and establishments, such as resorts, marinas, amusement parks, and ornamental gardens, also serve as primary interest areas and support services for people who seek enjoyment from the recreational resources associated with the Gulf. Visual No. 3 provides a synoptic view of the location, extent, and components of the recreational resources in the coastal and offshore areas of the CPA and WPA.

The two major recreational areas most directly associated with offshore leasing and potentially affected by it are the offshore marine environment and the coastal shorefront of the adjoining states. The only major recreational activity occurring on the OCS is offshore marine recreational fishing. Studies, reports, and conference proceedings published by MMS and others have documented a substantial recreational fishery including scuba diving directly associated with oil and gas production platforms (USDI, MMS, 1985). Offshore structures used for exploration and production of sulphur will be essentially the same as those used for oil and gas development. The recreational fishing associated with petroleum structures stems from their function as high profile artificial fishing reefs. A preliminary report on the 1984 Marine Recreational Fishery Statistics Survey presented by NMFS at the Sixth Annual Gulf of Mexico Information Transfer Meeting indicates a majority of the offshore recreational fishing in the CPA is directly associated with oil and gas structures. There are currently about 4,000 offshore oil and gas structures in the CPA and WPA. Many other studies (Ditton and Auyong, 1984; Roberts and Thompson, 1983; Ditton and Graefe, 1978; Dugas et al., 1979) have demonstrated that when petroleum structures are accessible to marine recreational fishermen and scuba divers they are a major attraction for marine recreational activities and are a positive influence on tourism and coastal economics. Interest is high throughout the Gulf of Mexico region to retain selected offshore structures in the marine environment as dedicated artificial reefs to enhance marine fisheries when no longer useful for oil and gas production.

Table III-8

Commercial Landings
(1985)

Species	Pounds	Dollars
Mississippi		
Shrimp, Saltwater	16,605,331	22,517,242
Menhaden	415,109,200	11,213,752
Oyster	1,192,650	1,499,004
Red Snapper	937,336	1,272,054
Blue Crab	1,648,901	538,024
Black Drum	2,543,113	503,225
Louisiana		
Shrimp, Saltwater	116,436,117	135,039,177
Menhaden	1,528,133,566	55,946,680
Oyster	14,347,231	23,757,852
Blue Crab	29,930,590	8,586,394
Red Drum	2,933,573	2,785,391
Catfish and Bullheads	5,665,221	2,674,592
Red Snapper	1,214,576	2,524,431

Source: USDC, NMFS, 1986c, personal communication.

Table III-9

Catch by Bay System

Species	Value ($)	Pounds
Atchafalaya and Vermilion Bays, 1985*		
Blue Crab	2,903,780	11,164,980
Shrimp (brown, white)	757,602	427,194
Red Drum	230,278	232,602
Flounders	38,501	50,360
Totals	4,228,292	12,448,881
Terrebonne and Timbalier Bays, 1985*		
Shrimp (brown, white)	11,291,782	8,430,064
Oyster	3,099,626	2,102,244
Blue Crab	950,099	3,652,357
Red Drum	197,319	182,222
Spotted Sea Trout	35,130	37,076
Black Drum	18,437	35,919
Catfish and Bullheads	2,072	5,164
Atlantic Sheepshead	1,860	15,111
Totals	15,597,808	14,466,062
Barataria Bay, 1985*		
Oyster	10,347,834	6,043,729
Shrimp (brown, white)	8,422,431	6,838,465
Blue Crab	1,693,096	5,404,591
Red Drum	1,283,136	1,141,327
Spotted Sea Trout	581,408	510,985
Black Drum	203,132	454,973
Catfish and Bullheads	199,790	428,035
White Sea Trout	62,759	109,998
Atlantic Sheepshead	30,116	270,105
Flounders	29,763	48,557
Totals	22,897,465	21,316,897
Breton and Chandeleur Sounds, 1985*		
Shrimp (brown, white, pink)	18,785,685	10,665,309
Oyster	10,662,707	6,534,379
Blue Crab	974,691	3,208,750
Red Drum	609,761	562,082
Spotted Sea Trout	311,844	279,070
Black Drum	200,597	929,392
Black Mullet	190,953	482,130
Pompano	51,728	11,614
Atlantic Sheepshead	49,418	406,353
Flounders	43,460	82,460
Totals	31,981,437	23,424,988
Lakes Borgne and Pontchartrain, 1985*		
Shrimp (brown, white)	6,343,247	5,006,897
Blue Crab	944,934	2,885,323
Oyster	120,652	74,033
Spotted Sea Trout	10,941	8,880
Black Drum	8,143	14,022
Red Drum	6,377	6,790
Flounders	1,663	2,832
Atlantic Croaker	841	915
Atlantic Sheepshead	412	3,914
Totals	7,513,671	8,068,499
Mississippi Sound, 1985*		
Shrimp (brown, white, pink)	8,194,119	3,557,976
Oyster	1,971,468	1,587,087
Blue Crab	708,419	2,059,418
Black Drum	317,326	1,606,506
Spotted Sea Trout	37,659	32,151
King Whiting (King Fish)	28,284	94,226
Flounders	23,971	38,401
Black Mullet	13,689	53,805
Atlantic Sheepshead	8,735	54,134
Totals	11,443,775	9,639,978

*Not all species are listed.

As noted on Visual No. 3, the coastal shorefront of the CPA and WPA contains extensive public and private park and recreational areas. Most of the recreational activity focused at the Gulf of Mexico shorefront is associated with accessible beach areas. Major recreational beaches are delineated on the front of Visual No. 3 and individually listed and further described on the back. Approximately 150 miles of linear shorefront in the WPA, or over 25% of Texas' exposed shoreline, is composed of major shorefront recreational beaches. Less than 10% of the CPA shorefront is composed of major shorefront recreational beaches; however, the Mississippi and Alabama shorefronts are noted for their extensive recreational beaches. These beaches are a major inducement for coastal tourism, as well as resident recreational activity.

Tourism is a multibillion dollar industry in the Gulf States associated with the CPA and WPA. The tourism industry accounts for over 100,000 jobs and, through tax receipts, provides a major source of revenue for State and local governments. Often times tourism is the primary industry in coastal counties such as Galveston, Texas, where recreational beaches abound. As was noted in an investigation of the tourism industry in Harrison County, Mississippi (Veal et al., 1984), beaches are a major inducement for tourists selecting travel destinations. Therefore, any threat to the quantity or quality of coastal recreation beaches from the OCS minerals leasing and development program may directly or indirectly impact not only beach-related recreational activities but the tourism industry as well. Hence, we are focusing our recreational analysis in Section IV on the impact of the Sulphur Sale on the major recreational beaches of the CPA and WPA, respectively. WPA recreational beaches are included in the analysis since they could be affected by the proposed action, particularly with respect to trash and debris.

10. Military Use/Warning Areas

Main Pass Area, South and East Addition, Block 289 (MP, SE-289) located in Eglin Water Test Area 1 (EWTA-1) is the only block offered for lease under the proposed action that is situated within a military area. EWTA-1 is currently used by the U.S. Air Force for rocket and missile testing. MP, SE-289 occurs along the western boundary of EWTA-1. Although conflicts are unlikely, a military area stipulation is proposed which would provide further mitigation against conflicts between the sulphur lessee of MP, SE-289 and DOD by providing safety considerations for the lessee to follow. (See Section II.A.3.b. for the stipulation and a discussion of its effects.) The stipulation was developed and has evolved through consultation and coordination between DOI and DOD. It has proven to be adequate for the needs of both organizations and has promoted effective multiple-use of the military areas. To date, there have been no reported accidents involving conflicts between OCS operations and military activities.

11. Archaeological Resources

Archaeological resources are any objects or features which are man-made or modified by human activity. Significant archaeological resources are either historic or prehistoric and, as defined by 36 CFR 60.6, generally include properties greater than 50 years old which are associated with events that have made a significant contribution to the broad patterns of our history; are associated with the lives of persons significant in the past; embody the distinctive characteristics of a type, period, or method of construction; represent the work of a master; possess high artistic values; represent a significant and distinguishable entity whose components may lack individual distinction; or have yielded, or may be likely to yield, information important in prehistory or history.

The State Historic Preservation Officers for all Gulf coast states were contacted and requested to indicate which sites on the National Register of Historic Places within their coastal zones could potentially be affected by OCS leasing activities. These sites, which include historic buildings, forts, lighthouses, and shipwrecks, are depicted on Visual No. 3.

a. Historic

Although most historic archaeological resources on the OCS are shipwrecks, other types of historic sites, such as the Ship Shoal Lighthouse, may occur in Federal waters.

Less than 2% of pre-20th century ships reported lost in the Gulf and less than 10% of all ships reported lost between 1500 and 1945 have known locations. Considering the problems with inaccurate wreck reporting, drift and breakup of wrecks, and ships which have been lost but never reported, it becomes apparent that very little is really known about the locations of historic shipwrecks in the Gulf of Mexico.

Based on the information provided by the archaeological resources baseline study, supplemented by information from the quarterly Defense Mapping Agency (DMA) printout of Nonsubmarine Contacts, MMS records show 51 shipwrecks with known locations in the CPA. Table III-18 of Final EIS 110/112 lists the wrecks by OCS lease block, and also lists the blocks within which, according to the position accuracy evaluation given in the Defense Mapping Agency printout, the wreck could possibly lie (US, DOD, DMA, 1982).

It should be emphasized that hundreds of other ships from all historic periods are known to have gone down somewhere in the Central Gulf; however, information on the location of these reported wrecks is not sufficient to allow mapping.

In order to deal with the management problems of this largely unlocated resource base, a high probability zone for the occurrence of shipwrecks, Zone 1, was proposed by the baseline study (CEI, 1977). This zone was delineated by using geographic factors, such as approaches to seaports, straits, shoals, reefs, and historic shipping routes as indicators of high shipwreck potential.

The major factor which would affect the integrity of shipwreck sites in the Central Gulf would be the unconsolidated Holocene deltaic sediments which comprise the bottom sediments in the eastern portion of the planning area. These sediments would provide protection of site components as they settled. An excellent example is provided by the recently excavated eighteenth century Spanish galleon, the *El Nuevo Constante*, off Cameron Parish, Louisiana (El Nuevo Constante, 1981). This wreck displayed excellent preservation of organic materials (e.g., leather, bone, and wood) due to the unconsolidated clays which encapsulated the wreck, creating an anaerobic environment. This type of wreck preservation would not be anticipated in the westernmost portion of the CPA where the bottom sediments range from outcrops of subaerially weathered clay to localized transgressive sand deposits.

b. Prehistoric

From the late Wisconsin maximum low sea stand (approximately 18,000 B.P.) until sea level reached its current high stand (approximately 5,000 to 3,000 B.P.), the OCS was subaerially exposed and inhabitable by terrestrial flora and fauna--including prehistoric man, who is known to have been in the Gulf Coast region since about 12,000 B.P. According to the sea level curve proposed for the northern Gulf by Coastal Environments, Inc. (CEI, 1982), sea level would have been approximately -45 m at 12,000 B.P. Therefore, the continental shelf shoreward of the 45 m bathymetric contour (archaeological zones 1 and 2) would have potential for prehistoric sites dating subsequent to 12,000 B.P.

The eastern portion of the CPA is characterized by Holocene deltaic deposits of the Mississippi River, ranging from several hundred feet thick to only a thin veneer. Subaerially developed natural levee ridges, delta front barrier islands, bays, and lagoons are abundant in this area. Sites around bays and lagoons would have a high probability for preservation, while natural levee sites may be preserved under the right conditions. Sites associated with relict delta front barrier islands would probably be extensively reworked and incorporated into the relict barrier island sands. The thickness of archaeologically sterile open-shelf Holocene marine sediments in some areas (generally closer to the active Mississippi Delta) may preclude recovery of site information in the underlying strata.

The western portion of the CPA is generally devoid of Holocene sediments, except in the extreme western portion where localized concentrations of transgressive Holocene sands reach thicknesses up to 7 m (USDI, MMS, 1984b). Many large, late Pleistocene fluvial systems are within a few feet of the seafloor in this area; an excellent example is provided by the ancient Sabine-Calcasieu River Valley. This ancient river valley was extensively studied and mapped by Nelson and Bray (1970) using borehole and seismic data. A study funded by MMS to locate prehistoric archaeological sites in association with the buried Sabine-Calcasieu River Valley has been completed recently. Five types of relict landforms, including valley margins/floodplains, terraces, natural levee ridges, point bars, and bay/estuary margins, were identified in association with this buried river valley. These landforms were further evaluated for potential archaeological deposits through the collection of original seismic data. Based on these data, vibracores were collected to evaluate areas of potential archaeological deposits. The final phase of this study attempted site identification through laboratory analysis of the core material. These sedimentary analyses suggest the presence of at least two archaeological sites at the locations tested (CEI, 1986). Lease block surveys from other areas have recorded evidence of numerous relict late Pleistocene fluvial systems ranging from a few hundred feet across with a maximum cut of 5-10 ft, up to several thousand feet across with maximum cuts of over 100 ft. Evidence of floodplains, terracing, and point bar deposits have been recorded in association with many of these fluvial systems. Sites located along floodplains and terraces, and within point bar deposits would be expected to have a higher potential for preservation than those sites located along the unprotected outer valley margins; however, these sites may also be preserved under the right conditions. Several examples of salt domes with bathymetric expression have also been recorded during lease block surveys in this area. Preservation of site materials associated with salt domes would be good within solution depressions and possibly in protected areas of rock outcrops associated with the salt dome. Due to the proximity of most of these relict landforms to the seafloor, the potential for further investigation and data recovery from these sites would be excellent.

12. Water Supply

Water supply problems have arisen as the result of a great influx of population and industry into the Gulf coastal areas. Although much of the Central Gulf experiences little to no water supply problems due to its extensive water resources, several areas including the southern portion of Texas are presently experiencing shortages of both potable and nonpotable water sources. As a result of the extensive offshore oil and gas industry and the small offshore sulphur mining industry in the Gulf region, varying quantities of water are presently needed to assist these industries with their exploration and development activities in the Gulf of Mexico. Large quantities of freshwater, largely nonpotable, are transported offshore and used on rigs/platforms during drilling and workover activities. Other OCS support activities requiring large quantities of water include the refining of crude oil and gas processing.

In general, the Central Gulf abounds in surface and groundwater resources with plentiful supplies of fresh surface water due to the high rainfall rates and upstream runoff into the coastal basins. Rain surplus, coupled with favorable geologic conditions, has enabled extensive groundwater aquifers to develop throughout this region. Although plentiful water supplies abound here, continuous and cyclical groundwater pumpage takes place throughout the Central region, and in the last few decades declining water levels have reversed the direction of the hydraulic gradient in many area aquifers, resulting in saltwater intrusion. Although there are numerous cases of saltwater intrusion throughout the region, surface water surpluses aid in maintaining the freshwater head necessary in preventing serious saltwater intrusion problems in the Central Gulf.

Although Louisiana has one of the most abundant supplies of ground and surface water in the United States, recent studies conducted by the State point to a growing awareness that economic growth and human activities both above and below the ground are degrading the quality of its water resources. These factors, coupled with the natural processes of erosion, subsidence, and the predicted sea level rise, currently threaten the future potential of these resources. In general, it was thought that the supplies of this area far exceeded the demands; however, as is the case with many of the coastal parishes, adequate water supplies do not always abound in those areas of need.

Many of the water supplies of the coastal communities near the fresh/saline interface are now and will continue to be affected by saltwater intrusion. Grand Isle, a barrier island resort community in southern Louisiana, is a prime example of this. This community is virtually isolated from any source of freshwater and at present imports some 500,000 gallons of freshwater per day from the Leeville, Louisiana, area some 12 miles west of Grand Isle. It is estimated that Grand Isle's water need will double in the near future as a result of the increase in the area's population by summer recreationists. The demand on the water supply is so acute during the summer months that industries and visitors alike are rationed in their use of this precious commodity. Both surface and groundwater sources are either brackish or saline; therefore, the additional water needed will have to be obtained by importing water, desalinating water, or treating wastewater. Areas experiencing similar problems with saltwater intrusion are the City of Houma, in Terrebonne Parish, and all of the Plaquemines Parish area. These areas presently draw freshwater from two of the major sources of freshwater in the southern portion of the state; Houma from the Gulf Intracoastal Waterway and Plaquemines Parish from the Mississippi River. In both cases, the areas are in need of alternative sources of freshwater during periods of saltwater intrusion, some of which can persist up to 60 days in duration. In the Plaquemines Parish area, the parish has responded to the problem by storing water in tanks, interconnecting downstream systems with more upstream systems, diluting brackish water with freshwater from storage, and promoting water conservation. Despite the efforts of the parish to combat the effects of this saltwater intrusion problem, the problem seems to be worsening as result of elevated rates of land loss within the area.

In contrast to the saltwater intrusion problem, many of the areas of the State are faced with the potential problem that their water supplies can be or are being polluted by industrial discharges from both point and nonpoint sources. This is the case with the River Parishes, which consist of St. James, St. John the Baptist, St. Charles, Jefferson, Orleans, St. Bernard, and Plaquemines Parishes. The primary source of municipal and industrial freshwater for these parishes is the Mississippi River. In this heavily industrialized reach of the river, more than 1.5 million people use about 214 million gallons of river water per day. A chemical or oil spill from a river vessel, industrial plant, pipeline, etc., is a constant danger. In the last 10 years alone, some 2,616 spills into the Mississippi River have been recorded by the Coast Guard. In the event the river was polluted and not usable, water users would have to either import alternative supplies or use water previously stored. For a 15-day emergency period alone, the River Parishes would require some 200 million gallons per day.

Continued population and industrial growth in the coastal region is expected to significantly effect the water consumption throughout the potentially affected coastal area. In some areas, this new growth and development is likely to be substantial enough to require the modification/expansion of existing water supply and treatment facilities. In certain areas, the amount of economically available water resources will be a major constraint to new development.

IV. ENVIRONMENTAL CONSEQUENCES

A. DEVELOPMENT SCENARIOS

1. Proposed Action: Most Likely Find Scenario (M Scenario)

a. Resource and Offshore Infrastructure Estimates

The proposed action is to offer for salt/sulphur lease 51 bidding units containing a total of 153 blocks and about 725,000 acres of submerged lands. The Sulphur/Salt Sale Visual shows the location of the bidding units. The 51 bidding units are estimated to contain a total of 90 million long tons of sulphur. It is assumed that 55 million long tons or 61% of the total sulphur will be discovered, developed, and produced as a result of the proposed action.

The total number of exploration and delineation wells, production and auxiliary platforms, development and sidetrack wells, bleedwater wells, and miles of pipeline (water and gas) estimated to be used for the discovery, development, and production of the 55 million long tons of sulphur are presented in Table IV-1. The following additional assumptions are also used in the analysis:

- Three economically recoverable sulphur deposits will be discovered.
- To develop these deposits three sulphur mines will be established.
- Each sulphur mine will consist of a complex of activities and related infrastructure. The infrastructure will include:
    - three production platforms,
    - one power plant platform,
    - two additional auxiliary platforms,
    - one pipeline to supply fuel (gas for the power plant),
    - one brine (salt) well drilled from the bleedwater (auxillary) platform,
    - one small brine pipeline from the bleedwater (auxillary) platform to the power plant platform, and
    - possibly one pipeline carrying raw water from shore to the mine. The use of such a pipeline is assumed only for mines within 10 miles of a shore location which has sufficient available or a readily developable supply of new water. For this assessment, it is assumed that one mine will be supplied water by pipeline and the other two mines will be supplied water by barge.
- The estimated 15 million short tons of salt will be developed and totally consumed on site solely as an important component of the mining process, and will be discharged as bleedwater after its use.

The most likely, and for this assessment the assumed, method of transporting sulphur from the mine to shore is by barge (the use of pipelines is a possible, but very unlikely, alternative method of moving sulphur to shore). Using barges with special insulated 1,000 long ton sulphur tanks, a total of 55,000 barge trips would be required to transport the 55,000,000 long tons of sulphur. This amounts to an average of 4.9 barge trips per day over the 31-year production period, 1992-2022. Peak year production is estimated at 2,700,000 long tons (occurring in 2004); the average daily number of barge trips in the peak year is estimated at 7.4.

Table IV-1

Exploration, Development, and Production Assumptions/Estimates

Activity/Item		Total Years	Time Frame for Activities		
			First Year	Last Year	Most Intense Year(s)
Number of Bidding Units Offered	51				
Number of Blocks[1]	153	-	-	-	-
Number of Acres (1,000s)[1]	725	-	-	-	-
Resources Offered for Lease[2]					
Sulphur (millions of long tons)	90	-	-	-	-
Salt (millions of short tons)	25	-	-	-	-
Resources Leased, Discovered, Developed, and Produced					
Sulphur (millions of long tons)[3]	55	31	1992	2022	1998-2011
Salt (millions of tons)[4]	15	31	1992	2022	1996-2018
Offshore Activity/Infrastructure					
Number of Exploration and Delineation Wells Drilled	60	7	1989	1995	1990-1994
Number of Production Platforms Installed	9	9	1991	1999	1995
Number of Development Wells Drilled	324	26	1992	2018	1996-2011
Number of Sidetrack Wells Drilled	576	30	1993	2022	1999-2012
Number of Bleedwater Wells Drilled	120	27	1992	2019	1996-2012
Number of Salt Wells	3	31	1992	2022	1996-2018
Number of Power Plant Platforms Installed	3	5	1991	1995	1991, 93, 95
Number of Auxillary Platforms Installed[5]	6	5	1991	1995	1991, 93, 95
Gas Pipelines: Number/Miles	3/30	5	1991	1995	1991, 93, 95
Water Pipelines: Number/Miles	1/10	1	1993	1993	1993
Sulphur Pipelines	0	-	-	-	-
Brine Pipelines: Number/Miles	3/3	31	1992	2022	1996-2018
Deactivation of Facilities					
Platform Disposition: No. of Platforms	18	5	2019	2023	2019-2023
Transportation Activity: Average Number of Trips per Week					
Sulphur Barging[6]	34	31	1992	2022	1998-2011
Service Vessels[7]	20	35	1989	2023	2000
Helicopters[7]	54	35	1989	2023	2000
Onshore Facilities Used: Existing/New					
Staging Areas[8]	1-3/0	7	1989	1995	1990-1994
Support Bases[9]	1-3/0	32	1991	2023	1999-2008
Terminal/Storage	1-2/0	31	1992	2022	1998-2011
General Port Facilities	1-3/0	35	1989	2023	1999-2008
Platforms/Structure Fabrication Yards	2-4/0	10	1990	1999	1994-1996
Heliports	1-3/0	35	1989	2023	1999-2008
Pipeline Landfalls (emplaced)	0/0-2	3	1993	1995	1993, 95
Other Onshore Facilities	1+/0	35	1989	2023	1999-2008

[1] The total number of blocks and acres of submerged land which are contained in the 51 bidding units.

[2] The conditional mean case estimate of the total amount of economically recoverable resources in the bidding units offered for lease. These estimates should not be interpreted as indicting that there are economically recoverable resources (sulphur and/or salt) in each of the bidding units.

[3] The estimated amount of economically recoverable sulphur assumed to be leased, developed, and produced as a result of the proposed action. This estimate represents abut 60% of the total conditional mean case economically recoverable resources. The production time frame is indicated.

[4] The estimated amount of salt assumed to be leased and developed for use in the sulphur mining process. The production time frame is indicated.

[5] Auxiliary platforms/structures include those which might be used for bleedwater facilities, crew living quarters, offices, maintenance shops, and warehouses.

[6] The total number of round trips between the sulphur mines and shore-based terminal/storage facilities over the production period 1992-2022 is estimated at 55,000 (this assumes the use of 1,000 long ton capacity barges).

[7] Round trips between the sulphur mines and shore-based facilites.

[8] These areas are primarily used in support of exploratory drilling operations.

[9] These bases provide support services for development and production operations.

Onshore facilities used during the exploration, development, production, and activation phases of the hypothesized sulphur mining activity are included in Table IV-1. Up to 2 (0-2) pipeline landfalls (with a small amount of onshore routing) might be constructed to carry water (0-1 pipeline) and gas (0-1 pipelines) to one or more sulphur mines. Existing onshore facilities are estimated to be capable of providing support for all the other offshore operations with little or no expansion. A generalized layout for a typical sulphur mine expected to result from this sale is shown in Figure IV-1.

Table IV-1 also includes the estimated time frame for each of the listed activities: the year the activity begins; the year the activity ends; the year(s) in which the activity is most intense; and the total number of years in which the activity takes place.

2. Cumulative Activities (Cumulative Scenarios for the Proposed Action)

a. Cumulative Scenario Factors Related to the Proposed Action and Prior and Future OCS Sulphur/Salt Lease Sales

There are only two offshore sulphur mines in the world. Both are located in the Central Gulf of Mexico within 7 miles of Grand Isle, Louisiana. One, the Grand Isle Mine, is located in State offshore waters; the other, the Caminada Mine, is located in Federal offshore waters about 8 miles southwest of the Grand Isle Mine (Appendix C). Both mines are owned by the Freeport Sulphur Company. The Grand Isle Mine has been in operation since 1960 and is now producing about 0.7 million long tons of sulphur per year. At this rate of production the Grand Isle Mine may be virtually depleted in 5 or 6 years. The Caminada Mine is being reactivated and could start production in April 1988. This mine previously produced from March 25, 1968 to March 25, 1969, when production was suspended, and remained in caretaker status until recently. Further production from the Caminada Mine is estimated to occur over a 12-year period; however, an estimate of the expected total amount of sulphur to be produced is unavailable. Offshore infrastructure related to these two mines is as follows:

	Grand Isle Mine	Caminada Mine
Production Platforms	3	2
Power Plant Platforms	1	1
Bleedwater/Salt Well Platforms	1	1
Auxiliary Platforms	1	2

All of this is existing infrastructure. No new major facilities are expected to be developed, except for an additional barge unloading berth at the Grand Isle shorebase to handle the additional production from the Caminada Mine. Sulphur from the Grand Isle Mine is moved by pipeline to terminal facilities at Grand Isle, then transferred to barges which carry it to the Port Sulphur terminal. Sulphur from the Caminada Mine will be moved by barge to terminal facilities at Grand Isle, then transferred to other barges which carry it to the Port Sulphur terminal.

At present, there are no plans for sulphur sales in the Central Gulf subsequent to the proposed action; however, it is considered reasonable to assume that the sulphur industry will express an interest in additional future sales and that one or more such sales would be held. The amount of sulphur that might be discovered and developed as a result of these sales is very uncertain at this time. Nevertheless, for this assessment it is considered reasonable to assume that the remaining 35 million long tons of sulphur (not leased as a result of the proposed action) might be leased as a result of this sale. The amount of offshore activity/infrastructure to discover, develop, and produce this sulphur is assumed to be about two-thirds that estimated for the proposed action.

b. Offshore Oil and Gas Activity in the Central Gulf

The Central Gulf of Mexico is the most extensively and intensively developed area offshore for oil and gas activity in the world. This activity is expected to continue over the timeframe of the proposed sulphur/salt sale and contribute a significant number of impact producing factors that might result in adverse effects on the same resources

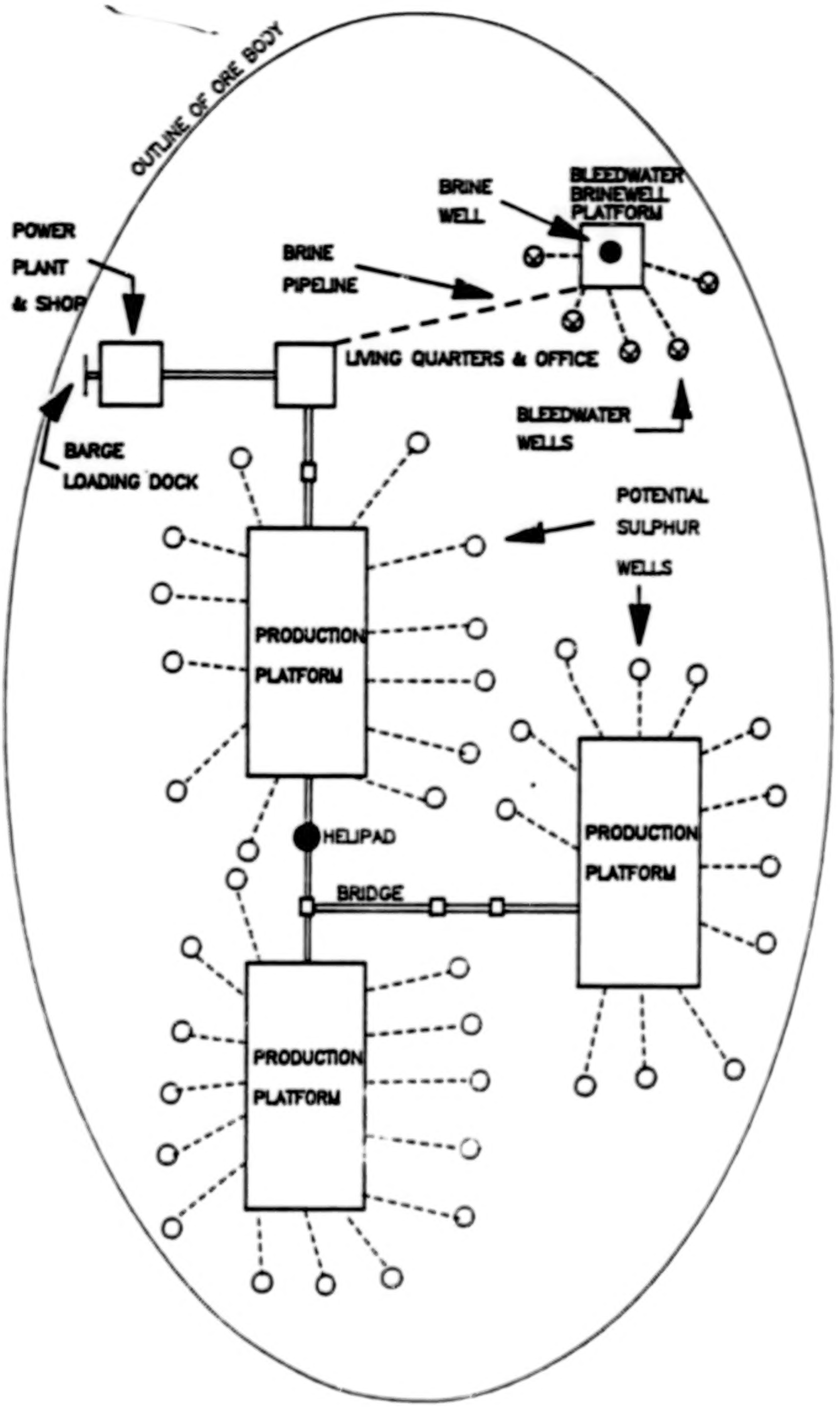


Figure IV-1. Generalized Layout of a Typical Sulphur Mine Expected to Result from the Sale.

Indications of the presence of sulphur had been detected by 1867 in Calcasieu Parish, Louisiana, but all efforts to mine this resource by conventional methods failed due to the overburden of swamp and quicksand. In the 1890's, Herman Frasch, a German-born petroleum scientist and chemist who came to this country at the age of 19, devised a method to melt it in place and pump the molten sulphur to the surface. The first flow of sulphur came to the surface in 1894, and eight years later, after numerous setbacks, the process was refined enough to become a commercial success.

Following exploratory and delineation coring to determine the presence of the sulphur formation, its thickness and areal extent, its porosity, permeability and sulphur content, a decision is made as to whether the deposit is economically feasible to mine. All drilling is accomplished using equipment that is essentially the same as oil drilling equipment. Sulphur completions are quite different from oil and gas, however.

Once the decision to mine has been made, a hole is drilled to the top of the cap rock and a 10- to 12-inch casing is cemented in place. Drilling continues until the bottom layer of the salt dome cap rock is reached. In order to get hot water down and sulphur back up, three coincentric pipes are inserted to the bottom of the hole. The outermost of the three pipes, usually 8 to 10 inches in diameter, has the lower section of the pipe perforated with small holes. It is inserted to the bottom of the sulphur-bearing formation. A 3- to 4-inch pipe is then inserted inside of the 8- or 10-inch pipe to within a short distance of the bottom (part way down the zone of perforations in the outer pipe). Inside of the 3- or 4-inch pipe, a 1-inch airline is inserted about half way to the bottom (to a depth necessary to airlift the molten sulphur up the annulus of the 3- or 4-inch pipe).

Water, heated under pressure to about 325°F (well above the 212°F boiling point of water), is pumped down the space between the 8- or 10-inch pipe and the 3- or 4-inch pipe, and during the initial heating period also down the inside of the 3- or 4-inch pipe. The superheated water flows out the perforations into the sulphur-bearing formation. This is known as "boosting" the well and takes some 4 or 5 days. (Figure B-1). The water used in steaming a well is treated to remove scale-forming salts and corrosive substances.

As the sulphur near the well bore reaches and exceeds 246°F (the melting point of sulphur), liquid sulphur flows to the bottom of the well since it is about twice as heavy as water. Pumping of water down the 3- or 4-inch pipe is then discontinued, but pumping continues in the annulus between the 8- or 10-inch and the 3- or 4-inch pipe. Static pressure of the water being pumped out of the upper part of the perforations forces molten sulphur in through the lower perforations and several hundred feet up the 3- or 4-inch pipe. (Figure B-1).

Compressed air at a pressure of 500-600 psi is forced down the 1-inch line into the molten sulphur, which lightens it and airlifts it the rest of the way to the surface. (Figure B-1). As the sulphur reaches the surface, it generally is directed to a flash pan or air-trap to separate the airlift air from the molten sulphur and to flash off any moisture that might be associated with the sulphur.

One well can take the sulphur from about one acre of cap rock area. The life of a well averages approximately 15 months, so new wells must be drilled continually and new lines laid to bring water and air to the well and molten sulphur back to the loading facility. Development wells often are initially vertical. After the zone being mined is depleted, the lower part of the pipe is retrieved and the lower part of the well is plugged and abandoned. The upper part of the hole is re-used by milling through the old casing and "sidetracking" out to complete the well in and mine an adjacent zone to the one originally mined.

Most of the hot water pumped down the well never returns, but instead forces its way outward from the mining zone in the cap rock and cools somewhat. In order to keep mining pressures at a desired level and to facilitate water flow, wells must be drilled around the periphery of the mining zone to "bleed" off this excess water. These are known as bleedwater wells. Often they are placed to direct the flow of injected water through future mining zones to preheat the formation. This bleedwater is returned to the surface, is collected at a central location, and is discharged into the Gulf of Mexico through a common header.

At some mines, unsuspected cavities and fissures in the formation which may drain off the hot water make a third type of well necessary. By draining off hot water, such cavities and fissures prevent production of sulphur. After years of study and experiment, it was found that wells can be drilled into the zone of cavities or fissures and tremendous quantities of mud pumped in to plug the underground openings.

Sources: Freeport Sulphur Company, 1978; Samuelson, 1986.

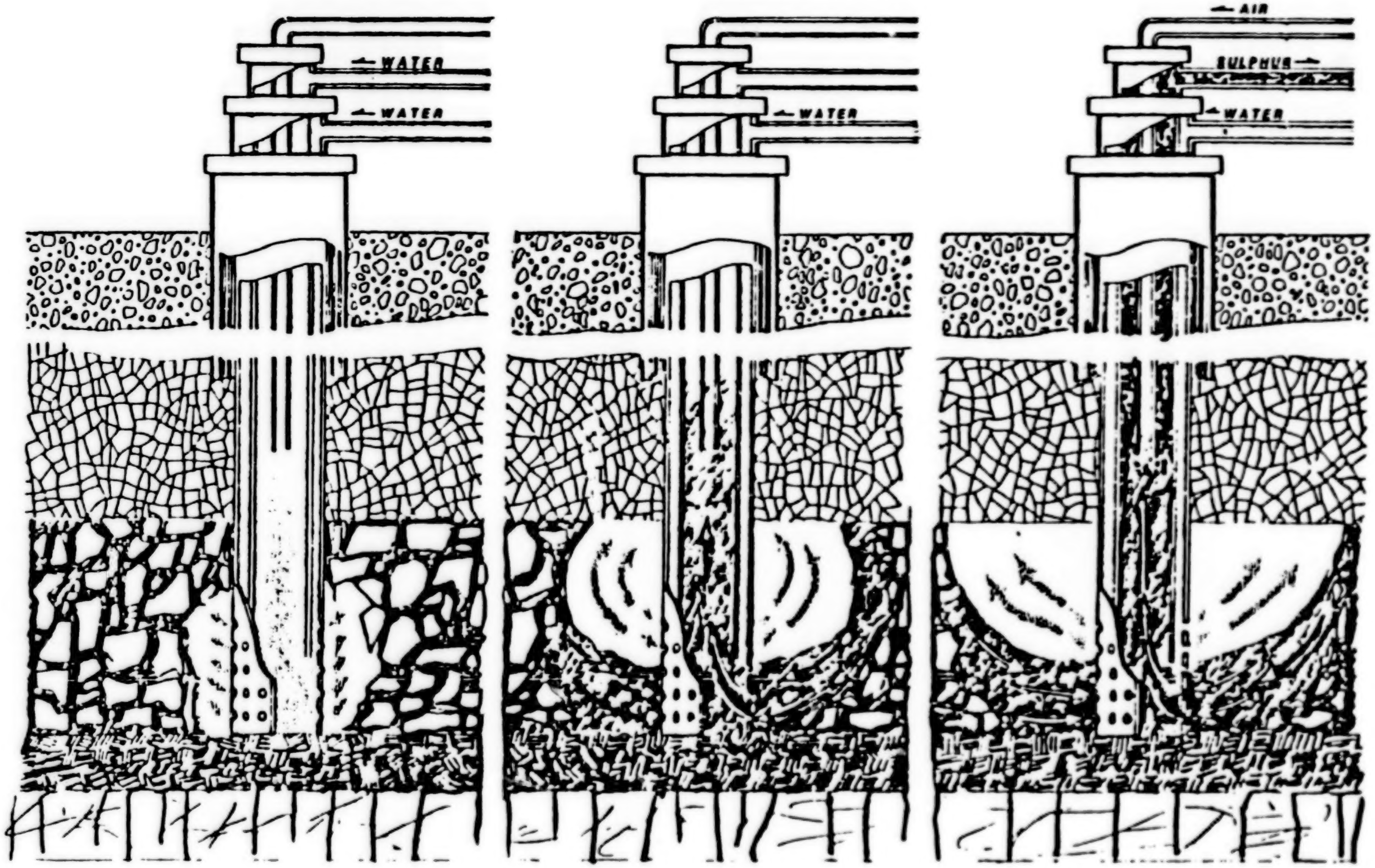


Figure B-1. The Frash-Mining Process for Sulphur.

Appendix C

Description of Existing Offshore Sulphur Mines

1. Grand Isle Mine

Sulphur was discovered in 1946 by Humble Oil Company while drilling for oil around a salt dome occurring beneath Grand Isle Area Blocks 9, 10, 18 and 19. Freeport Sulphur Company was assigned the sulphur rights in 1956 and constructed the Grand Isle Mine. The mine, completed in 1960 and put into production, stands in 50 ft of water some seven miles out in the Gulf and was the first offshore sulphur mine in the world. The sulphur-bearing zone varies from 220-425 ft thick and occurs some 1,800 to 2,000 ft below the seafloor. The mine was originally in Federal waters, but reverted to the State of Louisiana under the Supreme Court Supplemental Decree of 1975.

The mine consists of 5 large platforms and 10 smaller ones connected by nearly a mile and a half of bridges, making it the largest single offshore structure in the Western Hemisphere. The mine has a large power plant platform with shop facilities, a crew quarters/office platform, two conventional production platforms, one submersible production platform, and a bleedwater/brinewell platform.

To date, 10 test wells, 365 sulphur wells, 35 bleedwater wells and 3 brinewells have been drilled at the Grand Isle Mine. Many of the wells are highly directional, some being deflected up to 75 degrees from vertical. Freeport drillers are able to complete the highly directional wells within a 25-foot target at total depth. Some 20 to 25 wells are in production at any one time. The average well life for a sulphur well is around 15 months and 95% of the well failures are due to corrosion.

Salt is solution-mined and the brine is used as a mining fluid at the Grand Isle Mine. The higher salinity brine increases the density of the mining fluid and helps keep the heat down in the formation for improved heat distribution.

Sulphur from the wells flows into flash pans on the production platforms where the air-lift air is vented and any moisture associated with the sulphur is flashed off. Very minor amounts of H_2S and SO_2 are vented to the atmosphere from the flash pans. The molten sulphur then flows to a central pipeline where it is piped to shore on the east end of Grand Isle, Louisiana. From the shorebase on Grand Isle, the sulphur is transferred to the Port Sulphur terminal by barge.

The 7-mile sulphur pipeline consists of three coincentric pipes with two others strapped to the sides to form a bundle. A 14-inch protective casing contains an insulated 7 5/8-inch hot water jacket, which contains a 6-inch sulphur line. The hot water jacket is mounted on rollers within the protective casing to allow movement caused by thermal expansion. Strapped to the outside of the protective casing are a 6 5/8-inch freshwater line to the mine and a 4 1/2-inch hot water return line. Prior to any shutdown (i.e., evacuation for hurricanes, etc.), the entire system of flowlines, wells, and the pipeline to shore must be flushed of all sulphur in order to keep them from solidifying.

Freshwater piped from shore is used mostly for freshwater drilling muds. The Grand Isle Mine also uses two desalination plants, an osmosis type and a vacuum type. The plants normally operate at around 750 gallons per minute, and much of the water is used for the boilers and heat exchangers.

Depending on demand and sales, the Grand Isle Mine has averaged around 700,000 tons of sulphur production per year. It is estimated that enough sulphur remains to keep the mine in production for another 5 to 6 years.

2. Caminada Mine

The Caminada Mine, also owned by Freeport Sulphur Company, lies in Grand Isle Area Blocks 16, 17, 22, and 23, some 5.5 miles west southwest of the Grand Isle Mine. The mine is located in Federal waters. The sulphur-bearing zone is not as thick as the Grand Isle Mine, but is larger in areal extent, and is located some 1,750 ft below the seafloor.

Production was first initiated on March 25, 1969, and a total of 25 sulphur wells, 7 bleedwater wells, and 1 brine well were drilled. Exactly one year later, production was suspended due to a drop in the price of sulphur and loss of the sulphur pipeline to shore. The mine was in caretaking status until late 1986, when plans to reactivate the mine were approved by MMS. Production is scheduled to resume in early 1988.

Mining procedures are the same as used at the Grand Isle Mine. Plans call for 27 new wells to be drilled during the reactivation period and all sulphur produced is to be transported to the Grand Isle shorebase by sea-going sulphur barges. It is anticipated that two barge trips per day will be required and, based on 20 years of meteorological and oceanographic data collected at the mine, anticipated weather downtime may be only 5%.

The Caminada Mine consists of a power plant platform, a shop/warehouse platform, a living quarters/office platform, two production platforms, and a bleedwater/brinewell platform.

Production at the Caminada mine is projected to continue until around 1999.

Sources: Davis and Detro, 1984; USDI, MMS, 1986; Freeport Sulphur Company, 1978; Mickleberry, 1986, personal communication.

Appendix D

Sulphur Uses

Sulphur Uses
(Reprinted from Bureau of Mines Bulletin 675: SULFUR*, by David E. Morse, 1985)

Sulphur differs from other major mineral commodities in that most of it is used as a chemical reagent rather than as a component of a finished product. Its predominant use as a process chemical generally requires that it be first converted to an intermediated chemical product prior to its initial use by industry. In most of the ensuing chemical reactions between these intermediate products and other minerals and chemicals, the sulphur values are generally not retained in the final end product. Rather, they are more often discarded as a component of a waste product.

Sulfuric acid is the most important of these intermediate products. About four-fifths of U.S. sulphur consumption in 1983 was either converted to sulfuric acid or produced directly in this form. The sulphur sources for acid operations were Frasch and recovered elemental sulphur, 82%; nonferrous smelter gases, 8%; pyrites and miscellaneous sources, 3%; and return of dilute or contaminated acid, 7%. The acid plants using Frasch and recovered sulphur are almost invariably located close to the centers of sulfuric acid consumption because it is cheaper to ship crude sulphur than sulfuric acid. In addition, spent sulfuric acid was reclaimed by burning, regeneration, fortification, or concentration.

U.S. sulfuric acid production in 1983 was 33 million tons at 98 plants. More than 65% of the sulfuric acid was used in the manufacture of agricultural products, mainly in the Southern and Western States, near the sources of phosphate rock used in fertilizer production. Producers in the Southern States rely on Frasch sulphur as their basic source of supply for manufacturing sulfuric acid; producers in the Western States rely mostly on byproduct sulfuric acid produced by nonferrous metal smelters and either domestic or imported recovered sulphur from Canada.

The remaining 35% of the sulfuric acid produced was used for many purposes in essentially every domestic manufacturing industry. Its use was largely concentrated in the major industrial regions of the United States. The basic sources of supply were Frasch and recovered elemental sulphur.

Sulfuric acid, because of its combination of desirable properties, is the most widely used mineral acid. Its relatively low cost is the overriding consideration, in most cases, to utilize sulfuric acid rather than another mineral acid. It has less severe shipping, handling, and storage problems compared with those of other acids. It is widely adapted to numerous acidulation and neutralization processes and can be used in one process, reused in a second, or even a third process. It possesses excellent dehydrating properties and has a high boiling point, which limits losses in high temperature processes. It readily forms organic sulfates with many hydrocarbons that are easily hydrolyzed to form other basic products. Sulfuric acid is an effective catalyst in the synthesis of many hydrocarbon and organic chemicals.

The distribution of U.S. sulphur consumption in 1983 by end-use category was as follow:

Agriculture.- This category is by far the most important, accounting for about seven-tenths of domestic sulphur demand. The principal individual requirement is for the manufacture of phosphatic fertilizers, in which sulfuric acid is the essential intermediate sulphur product. The wet phosphoric acid process is the most important of those used for this purpose. Phosphate rock is digested with sulfuric acid to produce phosphoric acid and an impure waste gypsum product. The phosphoric acid is an intermediate product used for the production of a wide range of high-grade fertilizers such as dicalcium phosphate, diammonium phosphate, and triple superphosphate. Alternatively, but employed to a much lesser extent, phosphate rock is mixed with sulfuric acid in controlled, but lesser, quantities with the phosphorus content being converted to a water-soluble, lower grade normal superphosphate containing gypsum, which is marketed directly as a finished product.

Phosphatic fertilizers can be, and have been, produced in limited quantities by the electric-furnace elemental phosphorus method without acid or by the use of nitric and hydrochloric acids as substitutes for sulfuric acid. However, the economics of such processes are unfavorable except in certain limited areas of the world.

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* The spelling "sulphur" was used throughout the text of this reprint to be consistent with the official MMS spelling. The title of the section was left as originally spelled for reference.

Another individual, but relatively small, end use within this category is the production of ammonium sulfate by the reaction of sulfuric acid with ammonia. Additionally, a small quantity of sulphur in the elemental form, as sulfuric acid, or in the form of gypsum is used as a soil conditioner and plant nutrient. This use of soil amendment sulphur is growing in importance because the higher grade phosphatic fertilizers now being produced by the wet phosphoric acid process do not have the needed sulphur content.

Plastic and Synthetic Products.- This category covers a wide range of synthetics including acetate, cellophane, rayon and viscose products, fibers, and textiles. Together, they account for 4% of U.S. sulphur demand. The sulphur intermediates in their manufacture were equally divided between sulphuric acid and carbon disulfide.

Paper Products.- This category accounted for 2% of U.S. sulphur demand, with the largest single segment of demand being in the manufacture of wood pulp by the sulfite process. In this process, the major sulphur intermediate is sulphur dioxide, generally produced at the plantsite by burning elemental sulphur, although some sulphur dioxide is produced as a byproduct at smelter operations, purified and liquified, and shipped to the pulp mills. The sulphur dioxide, in turn, is converted to sulfurous acid, and the salt of this acid is a major component of the cooking liquor for the sulfite process.

Paints.- This category accounted for 1% of U.S. sulphur consumption. The major sulphur use in this category is for the production of titanium dioxide pigment by the sulfate process, in which sulfuric acid is reacted with ilmenite or titanium slag. The sulphur retorts as a ferrous sulfate waste. Difficulties with the disposal of this waste product have led to the development of the hydrochloric acid process.

Nonferrous Metal Production.- This category, which covers the leaching of copper and uranium ores with sulfuric acid, accounted for 3% of domestic sulphur consumption in 1983. Sulfuric acid is used to extract copper from ores, mine dumps, and wastes in which copper contents are too low to justify concentration by conventional flotation techniques, or to recover copper from ores containing carbonate and silicate minerals that cannot be treated readily by flotation. The sulfuric acid required for copper leaching is invariably the byproduct sulfuric acid produced by copper smelters in the area.

Sulfuric acid is the most commonly used reagent for the recovery of uranium from ores. This process often recovers vanadium as a coproduct. The sulfuric acid used is either produced from elemental sulphur or the byproduct of smelters.

Petroleum Refining.- This category includes not only petroleum refining as such but also associated chemical processes in which process streams may serve both the refinery and the chemical complex. Sulfuric acid requirements for those processes accounted for 7% of U.S. sulphur demand. About 75% of the sulfuric acid used in petroleum refining was returned as spent acid for reclaiming; therefore, the demand for new sulfuric acid was about 2% of the total sulphur demand. The major identified end use for sulfuric acid is as a catalyst for alkylation, a process by which liquid high-octane gasoline components with very good stability may be produced by combining gaseous streams. Sulfuric acid and hydrofluoric acid are competing catalysts in this process. Sulfuric acid for refinery processes is manufactured from recovered sulphur produced at the refinery and from contaminated acid (acid sludge) returned to the acid plants for reconstitution.

Iron and Steel Production.- Consumption of sulphur in the form of sulfuric acid accounted for 1% of domestic demand. The sulfuric acid is used as a pickling agent to remove mill scale, rust, dirt, and grease from the surface of steel products prior to further processing. Sulfuric acid used in pickling faces increasing competition from hydrochloric acid, largely because of the ferrous sulfate waste disposal problems. There is no well-defined source of sulfuric acid for steel pickling; it is generally obtained from merchant sulfuric acid plants that use the cheapest form of sulphur available.

Other Uses.- This general category covers a wide variety of end uses, including intermediate chemical products. Overall, however, they accounted for about 13% of U.S. sulphur consumption, largely in the form of sulfuric acid, but including some quantities of elemental sulphur that were used directly. These miscellaneous uses, especially those involving sulfuric acid, are intimately associated with practically all elements of the Nation's industrial chemical complexes.

END

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that might also be adversely affected by sulphur/salt mining. Table IV-2 lists the estimated amounts of oil and gas activity, infrastructure, and major impact producing factors expected to occur in the Central Gulf over the period 1988-2023.

c. Other Major Offshore Activities

The Gulf is the site of numerous activities that individually may be relatively innocuous, but when combined with the other major activities in the area could contribute to the cumulative degradation of the region. Among the most extensive offshore activities in the area of the proposed action are the exploration, development, and production of oil and gas resources in both State and Federal waters; general marine transportation and the tankering of imported crude oil; ocean dumping; military training and exercises; and, recreational and commercial fishing. These activities are described in detail in Section IV.A.2.c. of Final EIS 110/112 and are depicted on Visual Nos. 1 (oil and gas), No. 2 (commercial fishing), and No. 3 (recreational fishing, vessel safety fairways, military areas, and recreational fishing).

d. Major Onshore Activities in Coastal Areas

The major onshore activities that may contribute to the cumulative degradation of the region are oil and gas exploration, development, and production activities and facilities (including support facilities for offshore activities); waterway channelization and dredging; Mississippi River flood control measures; land reclamation; shoreline construction; and various forms of waste disposal. These activities are described in detail in Section IV.A.2.d. of Final EIS 110/112 and some are depicted on Visuals No. 1 (support facilities for offshore oil and gas activities) and No. 3 (navigable waterways).

Future onshore activities resulting from the proposed action will utilize existing facilities and thus, should not contribute to the cumulative degradation of the area.

3. Impact Producing Factors Related to Routine Offshore Support Activities

a. Effluent Discharges

Ancillary Sulphur Mining Wastewaters

Ancillary wastewaters resulting from offshore sulfur mining include boiler blowdown, reverse osmosis blowdown, heat reclaimer blowdown, miscellaneous effluents (i.e., platforms and plant washdowns, natural seawater overflows; uncontaminated bilge and ballast water, noncontact cooling water, steam trap condensate, and uncontaminated stormwater runoff) heat exchanges wastewater, minewater effluent, heater boiler blowdown, sanitary and domestic effluent, sulphur well sealing effluent, drill sub washdown, and potable water treatment blowdown. Boiler blowdown, a standard power plant effluent, consists of water treating wastes from softening units and seawater solids that accumulate in heating tubes and related piping. This discharge also includes reverse osmosis unit wastes (i.e., dissolved solids from feedwater).

Heat reclaimer blowdown is an intermittent wastestream which contains seawater solids and some residual sulfite which is used as an oxygen scavenger to reduce corrosion rates in piping. Miscellaneous effluents are characteristically untreated seawater, Mississippi River water, and steam condensate. Cooling water is defined by the USEPA as "noncontact" water used for cooling machinery. Heat exchanger waste water is an intermittent stream resulting from cleaning and flushing activities to reverse accumulated seawater solids and water treatment solids. Sanitary wastes are personal wastes from toilets and urinals, and domestic wastes and materials discharged from sinks, showers, laundries and galleys. Additional information on sanitary wastes is given in Section IV.A.3.a. of Final EIS 110/112 (USDI, MMS, 1986). Minewater effluent results only during start-up operations and emergency situations. The discharge of all or a portion of the minewater used in the Frasch sulphur mining process becomes necessary if unsafe pressure build-ups are detected in the system. This outfall typically occurs well above the surface water to allow atmospheric venting of heat. Heater boiler blowdown is an intermittent effluent typical of boilers used to heat facilities during cold months. Well sealing effluents are intermittent in nature and are a direct result of the Frasch sulphur mining process. In order to produce sulphur, the pipes that conduct the element to the surface

Table IV-2

Estimated Oil and Gas Activity, Infrastructure, and Related Major Impact Producing Factors in the Central Gulf: 1988-2023

A. Related to Federal OCS Oil and Gas

Aggregate Production[1]	
Oil (billion bbls)	6.90
Gas (tcf)	60.73
Offshore Infrastructure	
In Place	
Platforms[2]	3,655
Pipelines[3]	15,000
Estimated to be Developed[4]	
Exploration and Delineation Wells	2,560
Production Platforms	330
Development Wells	4,430
Pipeline (miles)[5]	2,400
Offshore Discharges[6]	
Drilling Mud Material (million bbls)	31.8
Drill Cuttings (million cubic yards)	3.6
Formation Waters (billion barrels)	6.2
Offshore Air Emissions: 1,000 tons[7]	
Nitrogen Oxides (NO_X)	180.6
Carbon Monoxide (CO)	32.3
Sulphur Oxide (SO_X)	4.6
Volatile Organic Compounds (VOC)	61.3
Total Suspended Particulates (TSP)	0.7
Transportation Activity: Peak Year Trips[8]	
Shuttle Tanker Traffic (500 dwt/200,000 dwt)	210/520
Service Vessel Traffic (1,000 trips)	21.0
Helicopter Traffic (1,000 trips)	112.6
Onshore Facilities: Existing-number/new-number[9]	
Service Bases	61/7
Pipe Coating and Storage Yards	19/4
Platform Fabrication Yards	10/5
Pipeline Landfalls	100/13
Onshore Pipeline (miles)	920/180
Marine Terminals	10/0
Gas Processing Plants	21/5
Oil Refineries	14/0

B. State Offshore Oil and Gas Activity

Structures[10]	800
Pipelines (miles)[11]	1,200
Production (annual)[12]	
Oil (billion bbls)	0.027
Gas (tcf)	0.313

Table IV-2. Estimated Oil and Gas Activity, Infrastructure, and Related Major Impact Producing Factors in the Central Gulf: 1988-2023 (continued)

C. Oil Spill Estimates: Prob. of One or More Occurrences/ Mean Number of Occurrences [13, 14]

Large Spills (≥ 1,000 bbls)	
Federal OCS Activity in Planning Area	99+/17.1
State Offshore Activity (aggregate)	67/1.1
Imports by Tanker (aggregate)	99+/32.4
Medium Spills (50-999 bbls)	
Federal OCS Activity in Planning Area	99+/96.6
State Offshore Activity (aggregate)	99+/6
Small Spills (1-49 bbls)	
Federal OCS Activity in Planning Area	99+/2,166.6
State Offshore Activity (aggregate)	99+/137

[1] Aggregate resources estimated to be produced subsequent to the date of the proposed action (over the 35-year period, 1988-2023). These resources include the projected reserves related to prior OCS sales in the planning area as of the date of the proposed action (April, 1983) plus resources estimated to be discovered and developed subsequent to the proposed action in the planning area (those related to the proposed action, prior OCS sales, and OCS Sales held subsequent to the proposed action during the period 1988-2023).

[2] Estimated to exist immediately prior to the proposed sale.

[3] As of 12/84, includes State-permitted pipelines originating in Federal OCS waters.

[4] Related to resources expected to be developed; added subsequent to the date of the proposed action.

[5] Gathering and main lines.

[6] Total discharges related to exploration and development activity.

[7] Total amounts related to exploration, development, and production activity. Occurring over the 35-year period, 1988-2023.

[8] Number of trips (outbound plus inbound). Shuttle tanker traffic related to the exclusive use of 20,000 dwt and 50,000 dwt tankers is indicated. It is probable that a mix of tankers with different capacities will be used so that actual peak year traffic would fall somewhere between the low and high figures listed.

[9] The minimum number of existing facilities expected to be used in support of OCS activity in the planning area; the largest number of new facilities expected to be used in suppport of OCS activity in the planning area.

[10] Single well, multiwell, and other structure types as of 12/31/83.

[11] Estimates as of 1981.

[12] For 1984. Production in the Central Area is listed.

[13] Resulting from the proposed actions, prior and future OCS sales, plus crude oil imports by tanker in the Gulf (large spills only), and continued oil production in State offshore waters (aggregate) over the 35-year period, 1988-2023.

[14] Average large oil spill size is estimated at about 17 thousand bbls; the average medium oil spill is estimated at about 154 bbls; and the average small oil spill is estimated at about 4.2 bbls.

must first be drained of water. This wastewater is a 10 to 1 mixture of minewater and formation water or bleedwater which will be discussed separately in this section. Drill deck washdown includes effluents from platform washings, deck washings, tank cleaning operations, and runoff from curbs, gutters, and drains including drip pans and work area drains. Potable water treatment blowdown are those wastes resulting from the creation of freshwater from seawater and consist primarily of calcium carbonate and other calcium salts. These discharges are regulated by USEPA through the NPDES (U.S. Environmental Protection Agency, 1985).

The ancillary wastewaters discussed above would be mostly small in volume, many would be intermittent in nature, and all would result from routine, well known processes not unlike those used in oil and gas operations (U.S. Environmental Protection Agency, 1985).

Treated Drilling Muds and Cuttings

Drilling rig discharges resulting from OCS sulphur mining consist of drill cuttings and drill fluids characteristic to that expected from shallow OCS oil and gas operations. Drill cuttings are mineral particles generated by drilling into subsurface geologic formations. Drill cuttings are carried to the surface of the wells by the circulating drilling fluids and separated from the fluids by solids separation equipment (screens and shakers) on the rig platform. Drilling fluid is defined as fluid sent down the wellbore, including drilling muds, gelling compounds, weighting agents, and any specialty products, from the time a well is begun until cessation of drilling for that well. Generally, two basic types of needs, water-bond or oil-based mud, are used in drilling. Oil-based muds (invested emulsion muds or oil emulsion muds) are mixtures of diesel or mineral oil and clays with water or brine emulsified in the oil (U.S. Environmental Protection Agency, 1985). Drilling muds are generally reconditioned and recycled in the relatively shallow depth well (2,000-3,000 ft) required for Frasch sulphur mining technology (Freeport Sulphur Company, 1985). Refer to Section IV.A.3.a. of Final EIS 110/112 (USDI, MMS, 1986) for further details concerning the use of drilling muds and cuttings.

Using 4,000 ft as a "maximum" well depth, 204 yd^3 of cuttings per well and 1,820 bbls of muds per well, the estimated total volumes of muds and cuttings discharges resulting from this sale under the M Scenario would be (1) exploration and delineation, 60 wells, 12,240 yd^3 of cuttings and 109,200 bbls of muds; and (2) development and sidetrack, 900 wells, 124,800 yd^3 of cuttings and 1,113,800 bbls of muds. The volumes of muds and cuttings for side track wells are estimated to be half of the amount for other wells. Although this is a great deal of material, it must be kept in mind that these amounts will be discharged into a very large body of water in which dilution and dispersion is rapid (i.e., four or five orders of magnitude within 10 m of the discharge point) and that such discharges will be over a period of several years (15 years is projected).

The physical fates of discharges, drilling fluids, and cuttings vary greatly. On the OCS, approximately 90% of the particles in discharges, drilling fluids, and almost all of the cuttings settle rapidly, passing through a stage of convective descent until encountering the seabed or becoming neutrally buoyant (Brandsma and Sauer, 1983).

Based on numerous symposia and reports of government- and industry-sponsored research, the following statements can be made: (1) many muds used in normal offshore drilling operations do indeed contain materials (such as chromium) toxic to marine organisms, but only at concentrations four or five orders of magnitude higher than those found more than a few tens of meters from the discharge point; and (2) dilution is extremely rapid in offshore waters to the extent that every substance measured in the water column, including turbidity, is at background certainly by a distance of 2,000 m, and probably within 1,000 m. Neff (1981) and Petrazzuolo (1981) confirm this: Menzie (1983) states that in several studies of the effects of drilling effluents that "Bioassays had revealed that the drilling discharges had little toxicity and it was thought unlikely that the observed effects were the results of toxicants." The observed effects were reduced benthic invertebrate abundance and were attributed to a change in sediment type (see below). In another study performed for Exxon, drilling fluids were discharged into Gulf waters at a high rate. The study (Ecomar, Inc., 1980) came to the following conclusions:

> Due to settling and dilution, suspended solids levels and metal concentrations drop quickly with distance near the discharge source. Concentration decreases of three to four orders of magnitude occur within 100 m downcurrent of the discharge source. Concentrations continue to fall, but at a slower rate, as the plume moves further away. Concentration decreases of five to six orders of magnitude occur at distances of 500-1,000 m. Soluble component concentration decreases were estimated to be some two orders of magnitude less than those observed for the suspended solids.

Furthermore, the National Academy of Sciences (NAS, 1983) made a comprehensive study of the fate and effects of drilling fluids in the marine environment. The conclusions of that report, including LC50 values, are discussed in Section IV.D.1.a.(2) of Final EIS 94/98/102. Based on the NAS findings, it is evident that drilling fluids used on the OCS are not likely to cause any significant ecological damage beyond 1,000 m from the discharge point either in the short-term or the long-term. At most depths typical of the continental shelf, the majority of discharged fluids and cuttings are initially deposited on the seabed within 1,000 m of the point of discharge. This material may persist as initially deposited or may undergo rapid or prolonged dispersion, depending on the energy of the bottom boundary layer. Effects on benthos have been observed in the field, under low to moderate energy regimes, within 1,000 m of the discharge point. This view was even more recently reiterated at a "Mobile Bay Area Drilling Fluids Transport Workshop" held on December 6-8, 1983. Conclusions from this workshop are discussed in Section IV.A.3.a. of Final EIS 110/112 (USDI, MMS, 1986).

In addition to toxic effects, the discharges, particularly the cuttings, form a low mound on the bottom beneath the discharge. Approximately 204 yd^3 of cuttings are disposed of during the drilling of an exploration well, depending on the depth of the well. Nonmotile plants and animals covered by this mound may be smothered, and to the extent that this mound exhibits different substrate characteristics (such as grain size, organic content, etc.) from the original bottom, the plants and animals which colonize the mound will be different. However, observations on such mounds show that they are colonized and reworked, and that after some period of time become indistinguishable from the surrounding bottom (Zingula, 1975). Furthermore, Menzie (1983) points out that it is the physical change of the substrate rather than any toxic effects which causes a change of benthic fauna around drilling rigs.

These discharges are regulated by USEPA through the NPDES system. No drilling mud containing free oil would be discharged as a result of the NPDES permitting (U.S. Environmental Protection Agency, 1985).

Bleedwater

In the Frasch mining process involving salt dome formations, pressure must be maintained at manageable levels. This requires the extraction of some of the ancient seawater and previously injected superheated seawater. This "bleedwater" constitutes the major wastewater stream in the Frasch process and contains concentrations of sulfides characteristically ranging from 800-1,200 mg/1. Aside from the elevated sulfide levels and a higher concentration of total dissolved solids, the wastewater stream is comparable to present day seawater (Freeport, 1985a). Salinities range from that of normal seawater to roughly twice normal seawater (Hunt, 1986). Based on the rate of discharge for existing mines, the rate of bleedwater for each mine resulting from this proposal would be 4.25 million gallons per day at peak production.

Analytical results indicate that the dissolved solids in typical bleedwater waterstreams closely approximate those of typical seawaters as shown in Table IV-3.

Sulfide in the bleedwater will have a very brief existence once the bleedwater is discharged into the sea because of dissipation to the atmosphere, dilution, and oxidation. While the toxicity of sulfides is derived primarily from hydrogen sulfide (H_2S), most sulfides present even in the immediate area of the bleedwater discharges will be in the form of hydrosulfides resulting from the higher (approximately 7.8-8.2) pH of the seawater. These hydrosulfides will be oxidized in the mixing zone due to the abundance of dissolved oxygen in seawater. Sulfates, the ultimate product of sulfide oxidation, are important nutrients and are seldom limiting in aquatic systems. In addition, available literature indicates that the natural variability of sulfates is greater than any positive variation that might result from this discharge. In brief, sulfides are extremely transient in nature and are rapidly converted via chemical processes and the ultimate product will be a normal seawater component, namely sulfates (Freeport Sulphur Company, 1985a).

In support of this conclusion, the Freeport Sulphur Company has collected water quality data for the Grand Isle Mine that reflect the short-lived nature of sulfides once discharged into Gulf waters. These data were based on results from a scheduled weekly water sampling program which was conducted between 1962 and 1971. "Test" samples were taken downcurrent of the bleedwater discharge at a distance of 500 ft. Control samples were taken upcurrent from the discharge. Parameters analyzed in this program were total reducing compounds (all sulfides would be included here), salinity, dissolved oxygen, pH, and temperature (Freeport Sulphur Company, 1985a).

Based on the results of this water sampling, Freeport derived an arithmatic mean concentration for total reducing compounds of 0.03 ppm for 1962-1969 at a water depth of 5 m (15 ft) below surface 152 m (500 ft) downstream of the discharge point and of 0.00 ppm for 1970-1971 at a water depth 2 m (5 ft) below surface and at bottom 152m

Table IV-3

Comparison of Seawater and Untreated Bleedwater

	Seawater mg/l	Typical Untreated Bleedwater (mg/l)
Total Dissolved Solids	34,482	24,600-161,225
Chlorides (Cl^-)	18,980	13,000-79,000
Na^+ and K^+ as Na^+	10,780	8,000-48,363
Other Dissolved Solids	4,772	5,400-33,857
Total Sulphur Other than Sulfides as SO_4	2,649	2,700
SO_3^-	0	0
B	4.3	8.6
F^-	< 1.0	< 1.0
NO_3^-	15	12
K^+	560	460
Mg^+	1,272	240-540
Ca^+	400	1,360
Si as SiO_2	5	80
Br as Br^-	65	82
Sr	13	60
Sulfides as H_2S	0	800-1,200
pH	8.5	6.2-6.6

Data on seawater determined from Firth (1969) or previous Freeport Sulphur Company analyses.

Source: Freeport Sulphur Company, 1985a.

(500 ft) downstream of the discharge point. Total reducing compounds include not only H_2S but all sulfides. There was no available data presented on the percentage of H_2S found in these amounts; however, it is unlikely that undissociated sulfides (H_2S) would be found in seawater with a pH ranging from 7.8-8.2. Generally, H_2S is not found in water with a pH level beyond 7.0. In water having a pH level ranging from 7.8-8.2, elemental sulfur would be expected to reduce to large amounts of sulfates (SO_4) and smaller amounts of hydrosulfides (Freeport Sulphur Company, 1985a).

Therefore, a statistical analysis of the Grand Isle Mine data showed that ambient conditions (based on a comparison of "test" to "control" stations) for sulfides were reached in the downcurrent quadrant at a distance of 500 ft from the bleedwater discharge. In addition, salinity (or chlorides) and all other parameters sampled showed that background levels were reached at this same distance (Freeport Sulphur Company, 1985a).

The bleedwater would not be purified prior to release; it would most likely be dispersed through ports located approximately 5 m (15 ft) below mean sea level. These dispersion ports directed upward at an approximate 45° angle would promote maximum mixing with the receiving seawater.

Some amount of sulfides will be dissipated to the atmosphere near these discharge points because of the following factors: (1) design and placement of the discharge points to produce an "effervescent effect" at the Gulf surface; (2) volatization of sulfide gases; and (3) a "stripping" effect on sulfide gases due to other gases (carbon dioxide and small amounts of methane). It is difficult to quantify the magnitude of the reduction of sulfides from these processes; however, it will certainly be a favorable factor in reducing the level of sulfides as the bleedwater is discharged into the mixing zone (Freeport Sulphur Company, 1985a).

In addition, as discussed in detail previously and in item (1) above, chemical oxidation of sulfides will occur in the mixing zone. Ostlund and Alexander (1963) discussed the oxidation of sulfides in seawater in some detail and presented chemical formulas depicting the kinetics of this process. They demonstrated that when there is dissolved oxygen available at a concentration of 200 mm (equals approximately 6.4 ppm), then the oxidation of sulfides is a first order reaction. Data from Freeport's long-term sampling in the Gulf of Mexico at the Grand Isle Mine show a 10-year mean of over 6.4 ppm oxygen (Ostlund and Alexander, 1963).

The seasonal degradation of the marine environment is expected as a result of dissolved oxygen depression due to the bleedwater discharge. Data from Freeport's long-term sampling at the Grand Isle Mine supports this assumption in that the actual mean analytical values for the first eight years monitoring showed a decrease in dissolved oxygen of 0.1 ppm (± 2.0 derived from two standard deviations) at "test" stations 500 ft downstream of the discharge at -15 ft versus ambient, upstream ("control") concentrations. The last two years of monitoring data showed no differences in the mean values between "test" and "central" stations at -5 ft and bottom sample depths (Freeport Sulphur Company, 1985b)

Computer modeling was conducted by Middle South Services Inc. for Freeport Sulphur Company to determine isotherm distribution within the mixing zone from the discharge point to 500 ft prior to reactivation of the Caminada Mine. Ambient water temperatures for summer and winter were selected through comprehensive review of years of data taken by Freeport Sulphur Company in the Gulf of Mexico at the Grand Isle Mine. These data show a mean winter temperature of 62.6°F and a mean summer temperature of 84.3°F at -15 ft depth. The bleedwater discharge used in the modeling was a temperature of 160°F. The model was conducted over a range of current velocities from 0.3 feet per second up to 8.44 feet per second. A review of the resultant data indicated that in no case was there even a 1°F rise above ambient beyond 139 ft from the discharge and for the vast majority of situations a 1°F rise above ambient was not evident beyond 50 ft from the discharge point (Freeport Sulphur Company, 1985b). The daily average discharge limitation required as part of the USEPA NPDES permit for bleedwater temperature at the Caminada Mine was less than 1.0°F at a point 500 ft down current of the discharge (U.S. Environmental Protection Agency, 1985).

A monitoring program for the detection of sulfides was incorporated into the NPDES permit for the reactivation of the Caminada Mine. The purpose of the monitoring program is to assess the fate and effect of sulfides from the bleedwater discharge. However, the Caminada Mine reactivation activities were not scheduled to begin until early 1987 so long-term results of this program will not be known for some time. Little information currently exists concerning impacts from sulfide laden discharges in the marine environment immediately adjacent to a sulphur production site. Freeport Sulphur Company, however, does report that years of testing at the Grand Isle Mine have shown no evidence of bleedwater 300 ft from the platform. In contrast, USEPA's NPDES permit for the Caminada Mine is less stringent than Freeports' reported results, requiring less than 1 mg/l 500 ft down current of discharge. Freeport is also required to report daily the amount of sulfides present in the bleedwater prior to discharge to receiving waters (U.S. Environmental Protection Agency,1985).

Nonpoint and Point Source Pollution

These pollution sources would result primarily from the operation of onshore facilities and construction, if required, and would consist of site runoff which might contribute particulate matter, heavy metals, residual acidity, petroleum products, and chemicals into local streams, estuaries, and bays causing temporary elevations in pollutant and turbidity levels. During site preparation the vegetation is cleared from the area, the topsoil is exposed, and the soil profile is altered by grading and leveling operations. The soil is compacted by constant movement of heavy machinery, which in turn alters the retention properties of the soil and gives rise to increased erosion and runoff from the site. By controlling the erosion generated within the construction site boundaries, several of the adverse impacts can be localized and prevented from having offsite impacts on water bodies. Land clearing and associated development changes the natural process of stormwater runoff, causing the volume and rate of runoff to increase as the natural vegetation is modified. Two major pollutants are contained in this runoff--suspended solids (organic and inorganic) from exposed soil at the site and contaminants such as heavy metals. Suspended solids may significantly decrease light penetration in water, thereby decreasing photosynthesis in aquatic plants. These may also cause abrasive injuries and gill clogging in fish and can smother eggs and larvae on the bottom. They may provide additional substrates for bacterial decay, leading to oxygen depletion of bottom waters. Alternately, they may contain nutrients which increase growth rates of endemic plant and animal populations. No new construction of onshore facilities is expected as a result of this proposed sale (Hunt, 1986). In addition, all surface water run-off (rainwater) is captured in ditches around the onshore sulphur storage areas and carried to a central reservoir. The pH is monitored and acidity is neutralized with caustic soda prior to discharge (Hunt, 1986).

Impacts of heavy metals or other contaminants contained in runoff on receiving waters will depend upon two factors. The first is the nature of the runoff and the level of concentration of heavy metals. The second factor is the nature of the receiving waters and the species diversity. Some heavy metals are extremely toxic, even in low concentrations, while others have a cumulative effect as organisms ingest them. As in the case of shellfish, water quality changes may not kill the resource but may contaminate it so that it cannot be safely used for a human food source or taints the flavor of the resource, making it undesirable for human consumption. These metals may also exhibit a toxic effect on consuming organisms higher in the food chain due to concentration increases with each step in the food chain (NERBC, 1976).

Other point source discharges expected from OCS sulphur mining-related support facilities would be similar in nature to that expected from OCS oil- and gas-related support facilities and would include onshore domestic wastewater, cooling and boiler water, process water, and in marine terminal areas, discharge of bilge or ballast water (Hunt, 1986). All steam used in the sulphur processing terminal comes from gas-fired boilers in the power plant (Hunt, 1986). Further discussion of these point source discharges is contained in Section IV.A.3.a. of Final EIS 110/112 (USDI, MMS, 1986).

Wastewater effluents from OCS sulphur mining-related support facilities would be commonly discharged to surface waters after treatment. Although the degree of environmental damage, if any, will be related directly to the toxic nature of the discharge and the biota in the receiving waters, certain characteristics of the discharge zone are important. These include: the size of the effective mixing zone (dilution factor) or the ratio of discharge volume to receiving volume; the flushing rate of residence time (estuaries characteristically have a slow flushing rate); and the physical-chemical characteristics of the receiving waters, e.g., marine waters have a higher buffering capacity than fresh or estuarine waters (NERBC, 1976).

Wastewater effluents from OCS-related facilities produce a wide range of responses in the receiving waters. Environmental responses produced will depend upon the quantity and kind of pollutants discharged or spilled. Heavy metals (such as zinc or copper), although often essential or nontoxic to organisms in very low concentrations, become toxic in higher concentrations. Even if the concentration of a heavy metal in the water is not toxic, it may accumulate in tissues with ultimately lethal effects. Ammonia can alter the pH of water, thus harming pH-sensitive organisms. Antifouling substances, which are added to cooling water to kill algae and bacteria, have similar effects on the organisms present in the water into which they are discharged. Suspended solids significantly decrease light penetration into the water, thus decreasing photosynthesis in aquatic plants. They also cause abrasive injuries and gill clogging in fish and can smother eggs and larvae by blanketing a stream bottom. Suspended solids which settle on the streambed provide additional substrates for bacterial decay, leading to oxygen depletion of the bottom waters. Thermal discharges can alter the chemical nature of receiving waters in many ways. Solubility of dissolved oxygen, toxicity of heavy metals, and metabolic rates of aquatic organisms are affected by changes in water temperatures (NERBC, 1976).

The environmental impacts associated with heavy metal pollution in the marine environment include both toxic and sublethal responses. Juvenile forms of many species of marine fauna are particularly sensitive, and an age class may be totally eliminated by a specific dosage of some heavy metal. Sublethal physiological alterations include depression of growth and photosynthesis in marine flora (NERBC, 1976).

Point source discharges will be subject to treatment by municipal and industrial facilities in compliance with Federal and State discharge permit requirements. NPDES permits are issued on a facility-by-facility basis, limiting the quantities of contaminants in and the temperature of each facility's effluent. These limits reflect a site-by-site specific analysis of flushing and mixing zone rates of the receiving body and indigenous population's ability to tolerate elevations of temperature and pollutant concentrations.

b. Air Emissions

The major impact producing factors on air quality from OCS-related sulphur recovery activity are due to combustion, evaporation, or venting of hydrocarbons. In the offshore environment, potential impact producing activity includes catastrophic events and operational emissions. Specifically, these events may be described as follows:

Offshore Activity

Catastrophic Events:
release of sour gas
(nonflared blowout
or with fire)

Operations Emissions:
exploratory drilling
platform installation
development drilling
barge loading (where applicable)

Onshore Activity

Sulphur Storage/Transfer
Sulphur Processing
Vessel Loading

In the onshore environment, potential impact producing activity includes the operation of sulphur storage and processing and vessel loading.

Offshore, effects of an immediate nature are those caused by catastrophic events such as blowouts with or without fire or the release of free hydrogen sulfide (sour) gas. Air emissions from these sources are rare and therefore of a nonroutine nature and can be expected to last for a short period. A factor influencing the effects of such blowout events is the volume of fluids released, the rate of release, and in the case of H_2S the distance to shore. Events that could occur on the OCS range from a minimum of 3 miles to as far as 200 miles from shore.

An unflared blowout in an area where sour gas exists could present serious health hazards within a radius of approximately three miles from the source. Concentrations of H_2S in excess of 400 ppm for 30-minute or less exposure are considered dangerous to humans and 700 ppm is estimated to be fatal to humans. Should an event occur, H_2S content of gas, local wind conditions, and other factors would control the impacts of the event. Uncontrolled emissions of this nature are unlikely to cause hazards onshore if the source is farther than approximately 4-5 miles offshore.

In the summer of 1984, two sour gas finds were publicly reported 3-5 miles south of Dauphin Island, Alabama. H_2S content was tested at 5,000 and 7,000 ppm for each exploratory well. Using these test results and assuming the most conservative (severe) conditions, a modeling effort to determine the dispersion characteristics of H_2S was undertaken. The conditions applied to the model included: (1) an unflared blowout above the water column; (2) three miles distance from shore; (3) a steady, gentle southerly wind; and (4) a persistent 26 million cubic feet/day duration. The results of this analysis indicate less than 1 ppm H_2S would be dispersed on the island. This level would probably not be detectable by human olfactory senses and would pose no threat to human or natural environments.

As discussed in the previous section, bleedwater contains concentrations of sulfides characteristically ranging from 800-1,200 mg/l, much of which is in the form of H_2S. Bleedwater is contained and discharged below the sea surface; however, an accident which would result in the venting of bleedwater into the atmosphere could result in H_2S emissions which could pose a threat to human safety in the immediate vicinity. Such exposure would probably be of short duration and the likelihood would be very remote.

Operational emissions due to offshore and onshore OCS-related activity may create effects of a more long-term nature. Air pollutants associated with OCS activities include nitrogen oxides (NO_x), carbon monoxide (CO), sulfur oxides (SO_x), total suspended particulates (TSP), and volatile organic compounds (VOC/hydrocarbon compounds). Ozone (O_3) is not emitted directly by any source; ozone is formed in a photochemical reaction in the atmosphere involving VOC and NO_x.

Operational emissions from offshore activity and onshore activities typically emit constant levels of VOC, NO_x, CO, SO_x, and TSP. The levels of these emissions and the effect of these emissions on ambient air quality is of concern. Specifically, if normal operational emissions from these sources degrade the air quality of onshore areas such that the NAAQS are exceeded, a threat may exist to the public health and welfare of the affected area. Many conditions define the magnitude of this threat, such as the number of pollutants present, the concentration (density) of the pollutant(s), and meteorological conditions by area over time. Typical emission levels are shown for exploratory drilling operations and platforms within the Gulf in Tables IV-4 and IV-5.

Table IV-4

Typical Emissions for Exploratory Drilling Activity[1]
in the Gulf of Mexico
(tons)

NO_x	CO	SO_x	VOC	TSP
10.3	1.51	0.69	0.34	Unknown

[1] Assumes: 10,000' hole; 597,120 hp/hr; and a 30-day period.

Source: U.S. Environmental Protection Agency, 1977.

Table IV-5

Average Annual Emissions from Platforms
in the Gulf of Mexico
(tons/year/platform)

NO_x	CO	SO_x	VOC	TSP
74.14	13.89	1.15	31.29	0.348

Source: USDI, Minerals Management Service, Gulf of Mexico OCS Region, 1986 air emissions inventory.

c. Noise Emissions

Noise emissions resulting from OCS development are associated with the operation of offshore platforms, drilling rigs, seismic geophysical surveying, sulphur transfer and terminal facilities, onshore processing plants, pump stations, aircraft, and vessels. In addition, construction equipment used during the installation of the various facilities emits various amounts of noise. The degree of noise impact depends upon the emitted sound level and the proximity of the source to schools, hospitals, residences, and recreation areas.

Machinery noise sources found on drilling and production platforms are, generally, similar to those used for other platform operations. Special noise attenuated devices are sometimes used offshore to protect workers in their living quarters located on the platforms. Compressors and diesel engines are usually the loudest equipment on a typical platform emitting about 90 dBa at a distance of 15 m (50 ft). By comparison, a diesel truck under full load also emits about 90 dBa at 15 m. Although other sounds, such as banging of pipes may be more intense, they are of short duration. The possible impact of noise emissions on the biological environment is discussed in subsequent sections. This has a potential to degrade the underwater acoustic environment, and may also adversely affect Naval activities in certain areas.

In a quiet sea with light wind conditions, normal offshore platform operations would be inaudible beyond about 2 miles (assuming ambient background noise level of 40 dBa and attenuated due to sound wave spreading only). In rough seas and weather conditions, the offshore facility would be inaudible beyond about 1/8 of a mile (assuming 70 dBa background). Even under low background noise conditions normal operations of OCS platforms would not be audible from shore. Onshore noise levels could be slightly increased by vessel, vehicle, and helicopter traffic.

Most of the onshore processing and support facilities would necessarily be located in industrially zoned areas where noise would have a minimal impact. If adverse noise impacts could result, mitigation measures such as sound barriers (i.e., earthen berms, block walls, etc.) and mufflers could be utilized.

Human activities associated with OCS exploration and development, especially air and vessel traffic near nesting waterfowl and seabirds, could reduce productivity of some species and may cause abandonment of important nesting, feeding, and staging areas. Effects studies in the arctic indicate that arctic tern, black brandt, and common eider all show lower nesting success in disturbed areas (Gollop et al., 1974). Schweinsberg (1974) reported that snow geese were particularly sensitive to aircraft disturbance during premigratory staging. The responses of birds to human disturbances are highly variable. These responses depend on the species, the physiological or reproductive state of the birds, distance form the disturbance, type, intensity, and duration of the disturbance and many other factors. Waterfowl nesting on deltas and islands may also be disturbed by aircraft and vessel traffic, and some disturbance of molting and staging birds is likely to occur. However, effects studies by Ward and Sharp (1974) and Gollop et al. (1974) indicate that long-term displacement or abandonment of important molting and feeding areas due to occasional aircraft disturbance is unlikely.

Aircraft and vessel traffic, and human presence associated with OCS-related minerals activities could adversely affect marine mammals which occupy breeding, calving, and feeding areas in or near sale areas.

Short-term responses of whales to accoustical disturbances that have been demonstrated include: flight and startle response; vacating of an area; deflecting of migration routes; and changes in swimming, diving, and respiration characteristics. The degree of responses ranged from those so subtle that statistical analysis was necessary to determine whether or not a change had occurred, to total abandonment of an area for several years and return only when historic ambient noise levels were restored. There are many areas where industrial noise had been ongoing for several years; whales have continued to utilize these areas, to some degree, during their migration cycle. If accoustical disturbances persist in critical areas, long-term effects may result. Long-term effects may include: permanent abandonment of some habitats, physical damage to the whale's auditory system, and changes in some portion or timing of their migratory cycle. Areas where long-term effects may be most likely to develop are in habitats where ambient noise levels do not presently include high levels of industrial noises (e.g., summer feeding areas and overwintering areas) or where many whales use a small area intensively. Habituation may be possible if increases in industrial noise levels proceed at a very slow rate (20-40 years).

d. Physical Presence of Drilling Rigs, Platforms, Boats, and Barges

The exploration, development, and production of OCS resources consist of many phases of activity including the initial survey with medium to small size vessels, the placement of exploratory rigs, support from local bases utilizing crew and work boats, placement of platforms for long-term use, the use of barges and work boats in support of production activities, and barging of production to shore. All these activities affect their surroundings merely due to their presence in the area.

An increase in ship or boat traffic in an area may or may not have an impact on the area, depending on existing conditions. It is possible, however, that any increase in vessel traffic could pose additional transportation safety hazards in an area heavily traveled or particularly difficult to navigate. If existing port and supply facilities are to be used, as is the assumption regarding activities resulting from this proposal, increased usage may affect their adequacy to meet all commercial needs.

The presence of offshore rigs and platforms occasionally conflicts with commercial and sport fishing interest for space. However, this is often offset by the fish-attracting capabilities of the structures. Commercial fishing would be most affected by the presence of offshore structures. If a rig is placed in productive fishing grounds, commercial fishermen would assume the burden of safe navigation around these obstacles without entangling their gear.

All platforms and rigs are obstacles to local navigation. It is fortunate, however, that these structures are quite visible to mariners due to their size and lighting. One of the most pronounced factors regarding OCS activities is the visual impact these operations have on the surrounding area. The majority of the tracts offered are far offshore where structures do not interfere with the aesthetic value of the coastal areas. However, off Louisiana, blocks are being offered just beyond the 3-mile State/Federal boundary where potential OCS operations in these areas may impact the visual value of the surrounding area. On clear days, drilling rigs may be seen for a distance up to 15-18 miles from shore depending on the height of the drilling derrick.

Rig and platform emplacement will result in disruption and suspension of sediments only in the immediate vicinity of the site. Displaced material or the physical presence of the rig or platform can smother burrowing and attached benthos. Increased turbidity resulting from rig and platform emplacement can temporarily clog the respiratory organs of many marine organisms and the filter-feeding mechanisms of numerous others. This increased turbidity is a short-term phenomenon, and generally is not significant beyond a few hundred meters from the site of the rig, platform, or associated anchors.

e. Accidental Sulphur Spills

Accidental spills of molten sulphur into the marine or coastal environment could occur as a result of accidents in the production or transportation of the sulphur. Elemental sulphur melts at 246°F, flows well at higher temperatures, but becomes extremely viscous as the temperature approaches 370°F (Haynes, 1959). Most liquid sulphur is approximately 270°F to 320°F when it leaves the production platform. Thus, any spill from the top of a production platform would form small pearls, solidify instantly, and while there might be a slight bouyant effect initially, the sulphur would sink. A spill of molten sulphur at the surface would result in a small amount of observable dust on the water surface but the majority would cool rapidly to ambient temperature and solidify upon contact with seawater and would sink (Breeding, 1986). Impacts to immobile bottom-dwelling organisms could result from burial by the sulphur in event of a spill. If liquid sulphur (320°F) is rapidly cooled to atmospheric temperature, a rubber-like mass results which is fairly stable and would withstand a great deal of mechanical working without solidifying. It would, however, solidify in a few days making its isolation and recovery expedient (Tuller, 1954; USDI, MMS, 1986). Freeport Sulphur Company reported one known sulphur spill involving a barge that sank in 1979 in Mobile Bay. The liquid sulphur was reported to have solidified inside the barge and was ultimately salvaged.

Thermal impacts resulting from the introduction of 320°F molten sulphur into the marine environment would be extremely localized and would be of short duration. Nonmobile and semimobile organisms in the vicinity of such a spill could be severely impacted. Solubility of dissolved oxygen, toxicity of heavy metals, and metabolic rates of aquatic organisms are affected by change in water temperture (NERBC, 1976).

Chemical impacts resulting from a liquid sulphur spill would be minimal. Sulphur is a tasteless, odorless, non-metallic element which is insoluble and chemically inert in water. In aquatic biological systems it may be slowly oxidized to sulfate and bacterial action on the surface of sulphur can produce minute amounts of sulfuric acid; however, in a marine environment, it would be diluted so rapidly as to be unmeasurable (Haynes, 1959; Mickleberry, 1986, personal communication). Liquid sulphur is rated as having low toxicity, low flammability, low reactivity with water, no solubility (less than 1 ppm), moderate persistence in aquatic environments, and a low chance for bioaccumulation (bioaccumulates to less than 100 times water concentration).

The recommended methods for handling a sulphur spill include removal or burial; however, a solid mass of amorphous sulphur may be difficult to recover with conventional dredging equipment. Burial, on the other hand, would be mainly for aesthetic reasons as sulphur is considered to be such a comparatively harmless material that leaving it uncovered would be nearly as safe an option. Burial would, however, prevent fouling of beaches or shorelines should the spill be in proximity to such a resource. As solidified sulphur may be slowly acted upon by bacteria to release sulfuric acid, an inert covering material could be used to retard this phenomenon if the sulphur is to be buried. A buffering agent could also be added to neutralize any acid produced (Breeding, 1986).

The only emissions associated with an accidental spill of liquid sulphur at temperatures greater than 246°F when introduced to cold seawater would be steam and would be of very short duration, very localized, and would dissipate rapidly.

f. Subsidence

The removal of cap rock sulphur in the mining process leaves cavities in the cap rock. Subsequent collapse of the cap rock can occur, resulting in substantial subsidence of the seafloor or ground above the mining zone. Sulphur mining experience throughout coastal Louisiana and Texas has shown that the amount of subsidence is extremely hard to predict. Subsidence depends on many factors, including thickness of the sulphur deposit, proximity of the sulphur-bearing zone to the surface, and vuggy porosity and strength of the cap rock. These parameters are impossible to determine without drilling. Some mines in coastal Louisiana and Texas have experienced no subsidence while others have experienced a great deal. Over the life of the Grand Isle Sulphur Mine, some 70 ft of subsidence has occurred (Mickleberry, 1986, personal communication). Subsidence was examined at a number of mines onshore and at the Grand Isle Mine, and based on this examination, an average of 40 feet of subsidence was arrived at for impact analysis in this document.

Subsidence is beneficial to the mining process because it seals off the cavities in the zones already mined and aids in directing the flow of hot water to those parts of the cap rock not yet mined. Collapse of the cap rock can cause distortion of strings of pipe or the loss of the sulphur well, and can damage surface installations in the vicinity of the well. Typically, the defense against subsidence is to drill and equip wells only as needed and to construct power plants and other permanent structures at points beyond the limits of any surface subsidence area (Hazleton, 1970). Production platforms located in the area of surface subsidence may need to be relocated or raised one or more times during the life of the mine.

Subsidence occurs only over the zone of cap rock being mined. Once that zone is depleted, the production platform is moved to a new zone of cap rock. Subsidence, likewise, could then occur over that zone of cap rock. Thus, the entire zone of sulphur-bearing cap rock could be subjected to subsidence over the life of the mine.

The removal of salt for sulphur mining activity could result in additional subsidence. Since the zone being solution mined for salt is generally much deeper than the zone being mined for sulphur, and it is beneath the lower portion of impermeable cap rock below the sulphur-bearing zone, effects of subsidence would be much less from salt removal than from sulphur removal. The subsidence from both activities may have a cumulative effect in the area over the mine.

Experience with the Grand Isle Mine has shown that subsidence from sulphur mining tends to have a minimal effect on the bathymetry in the vicinity of the mine. It occurs gradually in most cases, and the sediment influx caused by currents, tidal action, and storms fills any depressions as they form. Subsidence, however, can occur rapidly.

g. Ancillary Pipeline Construction

Although the probability of the construction of pipelines to transport sulphur is extremely unlikely, pipeline construction to transport fuel (gas), and possibly fresh water, to the sulphur mines resulting from this proposal is likely. Such pipelines would probably be relatively small in diameter (normally 5 to 6 inches in diameter) and would likely run from shore (if the mines are within 10 miles or so of shore) or from gas fields in the vicinity of the mine. Molten sulphur is typically transported back to a central shipping point at the mine from production platforms via insulated pipelines supported beneath the bridges connecting platforms. If it is assumed that this method of transport at the mine would be used for each of the three mines expected to result from this proposed sale.

It is assumed that for this proposal, three pipelines for fuel may result from the proposed action and that they will total 30 miles in length (10 miles each). Each mine is anticipated to have one bleedwater/brine well platform. Brine is likely to be pipelined along the seafloor to the power plant platform where it is treated and heated for use as the sulphur-mining fluid. Therefore, each of the three brine pipelines will likely be less than one mile in length, and of small diameter. Bleedwater will likely be discharged at the bleedwater platform, nullifying any need for another pipeline.

Federal offshore pipeline construction has been occurring in the Gulf of Mexico since 1951. Since 1970, annual pipeline construction associated with oil and gas has averaged about 600 miles. The "Regional Environmental Assessment of Pipeline Activities," covering the northern Gulf of Mexico region and the contiguous coastal zone, discusses regulatory procedures pertaining to pipeline installation associated with the Federal leasing program, describes the affected offshore and onshore environment, and discusses environmental impacts of the construction of pipelines on the OCS and nearshore region of the Gulf of Mexico (USDI, MMS, 1983a).

Pipeline construction, by whatever technique, always results in a certain amount of damage to the substrate. It is estimated that six acres of bottom are physically disrupted per mile of pipeline constructed and some 2,300-6,000 yd^3 of sediment are resuspended per mile, depending on the size of the pipeline and the depth of burial. These effects are more profound in coastal wetlands and may be further amplified depending on whether the pipeline is buried or whether an open canal has resulted from pipeline emplacement. Open canals promote saltwater intrusion and marsh soil erosion, but sometimes provide excellent sport fishing.

In offshore waters, some gear conflicts between pipelines and commercial trawl gear exists. Adverse impacts are small, however. The use of pipeline lay barge anchors during pipeline installation and the use of a jet sled or other device in pipeline burial have the potential to adversely impact other offshore resources.

h. Dredging Activities

Dredging of new channels and maintenance dredging of existing channels is required to provide safe and efficient navigation conditions for commercial and recreational marine transportation. Channel dredging generates significant amounts of dredged material consisting of the sediment and water mixture excavated from areas dredged. On the basis of volume, dredging is the largest single source of material that is ocean dumped. During 1979, more than 72 million cubic yards of dredged material were deposited with the marine environment (U.S. Dept. of the Army, Corps of Engineers, 1980). Of that total, 68% were disposed of in the Gulf of Mexico. The total constituted nearly eight times the combined tonnage of industrial wastes, sewage sludge, construction debris, and other waste material disposed of in the marine environment during 1979 (U.S. Dept. of the Army, Corps of Engineers, 1980). Compared with other materials that are disposed of in the ocean, most of the dredged material excavated in the United States is relatively innocuous, in many instances containing no harmful pollutants and, in most of the remaining cases, containing only trace levels of contaminants. In these cases, the primary concern associated with disposal of the relatively innocuous materials centers around the direct physical effects of disposal. These physical effects include burial of organisms, increased levels of suspended sediments, and accretion of disposed material (U.S. Dept. of the Army, Corps of Engineers, 1978). However, dredged material taken from highly polluted areas is usually contaminated with harmful chemical constituents such as heavy metals, synthetic organics, and oil and grease. Open-ocean disposal of these materials carries the threat of acute or chronic toxic effects on marine organisms and potential contamination of human food resources. Much research has been conducted to describe the effects of dredged material disposal in the marine environment and to evaluate disposal of options that may be preferable to ocean dumping.

Dredging of new navigation channels and deepening or widening of existing channels could result in wetland loss through loss of soil, saltwater intrusion, and increased erosion from vessel traffic (Section IV.D.1.a.(1)(b) of Final EIS 110/112). In general, dredging operations associated with construction projects would result in short-term, localized effects to fish by introducing sediment into the water column and by entraining fish in the suction head of the dredge. This could produce lethal effects through the entrainment or sublethal responses by inhibiting respiration or feeding activities through increased turbidity.

i. Seismic Operations

A complete description of seismic operations and their associated impacts is discussed in "Environmental Assessment for Geological and Geophysical Exploration Activities on the Outer Continental Shelf" (USDI, MMS, 1984c), and is summarized below.

Direct impact producing factors that are associated with seismic operations are subsurface impulses and the presence of vessel and associated trailing gear. Seismic operations involve the accurate measurement of the travel time required for an artificially-generated seismic (acoustic) wave to travel into the subsurface and return after being reflected or refracted by either unconsolidated sediments or rock layers below the seafloor. Sound sources for seismic operations include electric sparkers, air guns, sleeve exploders, electromechanical devices, and, rarely, explosives. A frame with an array of air guns is most commonly used.

Sparkers create an acoustic pulse by generating a powerful electric spark between submerged electrodes. Air guns explosively release a charge of high-pressure air into the water. Sleeve exploders ignite a bubble of gas (such as propane) in a manifold (sleeve). High-resolution seismic operations frequently generate their sound pulse by electrically causing two confined metal plates to separate rapidly.

Seismic operations on a particular lease conducted by a lessee or his contractor do not require a special G&G permit from MMS. Those seismic operations not confined to a particular lease or conducted over unleased acreage do require G&G permits. In 1986, 107 G&G permits were granted for offshore Louisiana. The number of G&G permits granted on the Gulf OCS for offshore Louisiana for the period 1963-1986 was 5,122. Those permits resulted in seismic operations totalling 153,492 line miles in the CPA (Kuzela, 1987, personal communication).

Marine geophysical surveys have caused concern among commercial fishing and environmental groups. These concerns are that the surveys are lethal, damaging, or disturbing to fish and other marine life and also are destructive to commercial fishing gear (crab pots). Additionally, there is information that seismic surveys may conflict physically and spatially with commercial fishing.

Whales' reactions to seismic activities vary between immediate response (e.g., flight and startle response) to seemingly no reaction, depending on how close the whales are to an active seismic vessel. Behaviors in whales are measured by changes in dive duration, surface duration, number of blows per surfacing, travel direction and speed, calling rate, respiration rate, and other dive characteristics.

Shock waves associated with seismic air guns would not immediately be harmful to marine animals (Geraci and St. Aubin, 1980), although noise may affect behavior. Other information (Dome Petroleum et al., 1982) suggests that while seismic and/or vessel noise might temporarily affect hearing, mask vocalizations or sound used to locate prey or predators, or result in temporary displacement if nearby, effects on regional populations are likely to be negligible.

j. Trash and Debris

Modern technological advancements, especially in regard to the development of cheap, durable, and lightweight plastic packaging materials and containers along with increased use by man of the Gulf of Mexico for work and play, has resulted in a persistent marine debris problem impacting living marine resources and coastal recreation shorefronts. Several years of discussion and analysis of trash loads affecting Texas beaches indicates that four major industries (petroleum, fishing, shipping, and recreation), as well as inland and foreign sources and military operations, are contributing to this problem. Sulphur operations will require people, supplies, and equipment offshore and will generate galley, cargo, and operational type wastes which could accidentally or purposefully be released into the marine environment.

k. Oil Spills

(1) Historic Spill Rates Associated with Sulphur Mining

No major oil spills have occurred which were directly associated with sulphur mining activities. Any oil spills expected to occur during mining operations offshore would likely be diesel fuel, lubricating oils, solvents, or other hydrocarbon products used in the daily operations of the mine and its support activity. Oil spill response teams are designated and trained for offshore mines, and oil spill equipment is available to accomplish a small-scale cleanup operation should any such substances be spilled. Since offshore sulphur mines operate on a 24-hour basis providing constant surveillance, the likelihood of such a spill going unnoticed and unmitigated is remote. Impacts to the environment from such a spill should be slight.

Other potential sources of an oil spill could be failure of existing pipelines due to subsidence caused by sulphur mining activity (Section IV.C.1.h.), or catastrophic blowouts (Section IV.B.2.).

(2) Chronic or Long-term Oil Pollution

(a) Sources of Hydrocarbon Inputs into the Gulf of Mexico

Sources which contribute as hydrocarbon inputs into the Gulf of Mexico include natural seeps, accidental spills, and long-term, low-level discharges. The presence of hydrocarbons in the marine environment is, to some extent, unavoidable. The hydrocarbons found in the world's oceans are generated by both natural and geochemical processes, and anthropogenic inputs. The majority of these hydrocarbons are introduced into the sea as a result of man's activities: coastal refining; industrial waste disposal; urban and river runoff; transportation losses; and offshore oil and gas activities.

Figure IV-3 of (Final EIS 110/112) illustrates the probable amounts of hydrocarbons which annually enter into the Gulf of Mexico OCS from the major offshore, coastal, and land-based sources. The Mississippi River discharge completely dominates petroleum loadings of Gulf waters (78.3%) with offshore domestic oil exploration and production activities adding only 0.6% annually to the petroleum entering the Gulf. Maritime transportation activities release an estimated 4.8%, with the majority of this coming from operational discharges of tankers. Natural seepage is the second largest contributor of petroleum to Gulf waters. For a more detailed discussion of this subject, see Table IV-26 and Appendix E of the Final Regional EIS.

(b) Sublethal and Long-term Effects of Chronic or Low-level Oil Pollution

The sublethal effects on marine organisms resulting from low-level chronic oil discharges and small spills may prove to be the most harmful impact to the marine ecosystem in areas exposed to long-term mineral exploration activities. Little is known about low concentration oil pollution and there exists too small a consensus to support any definitive assessment at present. It is not known if petroleum introduction into the marine environment is causing significant deleterious and chronic effects, and even more important if this contamination is producing a long-term significant alteration of the marine environment.

Sublethal effects are defined as those that impair the ability of an organism to function effectively without causing direct mortality, although these effects can be directly lethal. Usually sublethal and/or long-term effects are associated with low concentrations of petroleum which may be present in the marine environment due to chronic low-level oil discharges and small spills (less than 1,000 bbls) or from large spills in which evaporation, degradation, and dispersion of the spilled hydrocarbons ultimately result in the formation of sublethal concentrations.

Low-level chronic oil pollution may have more long-term harmful consequences to the ecosystem than the isolated large spills (i.e., spills greater than or equal to 1,000 bbls) which receive the most publicity. The issue over the effect of low-level oil contamination versus catastrophic spills seems to be supported from both sides. A more detailed discussion of sublethal and long term effects of chronic or low level of pollution is presented in Section IV.B..5. of Final EIS 110/112.

(3) Catastrophic Oil Spills (Blowouts)

Oil and gas resources are very commonly found in association with salt domes in the Gulf of Mexico basin, but often are found on the periphery of the domes. Current thinking is that hydrocarbons had to be present during the development of the dome to aid in forming elemental sulphur in the cap rock. Therefore, the chance of encountering hydrocarbons while drilling for sulphur does exist. Section IV.B.2. further discusses blowouts.

Shallow Tertiary sediments over most of the area have tended to be natural gas prone. Blowouts have occurred in coastal Louisiana while drilling for sulphur. Three rigs were lost, one thrown over, and one burned while drilling for sulphur at Garden Island Bay Mine when high-pressured natural gas was encountered at three levels (Haynes, 1959). Shallow natural gas was also encountered near the cap rock in the drilling of a well at the Caminada Mine in 1967, but it was harmlessly bled off to eliminate the hazard.

Blowout prevention equipment, diverter systems, and other well safety equipment are utilized in the drilling of sulphur wells, and drilling personnel are adequately trained in shallow gas control techniques. In addition, compliance with OCS Order No. 10 and NTL 83-3 is required during development procedures.

(4) Oil Spill Containment/Cleanup Capabilities and Effectiveness

The policy of the United States with regard to oil pollution response is depicted in the Clean Water Act with the development of a National Contingency Plan. The plan provides guidelines that serve as mechanisms of coordinating an effective response to oil spillage at the regional level. Available equipment is of no use without a preplanned approach as to how to use it. Improvements in prespill contingency planning at all levels of government and private industry in past years have reduced confusion and increased the efficiency and effectiveness of cleanup response. By knowing the nature of the spilled material, as well as slick dynamics, the characteristics of the threatened environment, and the available equipment and manpower, the responsible party can prioritize and evaluate selected actions.

The Federal response program, outlined in the Clean Water Act and National Contingency Plan, established on-scene coordinators (OSC), provided by the U.S. Coast Guard, to direct response for pollution or potential pollution incidents. Sections I.B.4. of this document and IV.B.5. (Volume 1) of the Final Regional EIS present a full discussion on the Federal response program.

A group of oil companies involved in petroleum transportation in the Gulf of Mexico has established the Marine Industry Group (MIRG), formerly the Marine Industry Research Group. Two of the subparts of MIRG are the Resources and Logistics Element and the Environmental Element. The Resources and Logistics Element identifies the location of specific cleanup equipment resources and provides deployment requirements and specifications. The Environmental Element describes the Gulf of Mexico environment, identifies biological and socioeconomic sensitive areas, and includes countermeasure considerations. A more detailed discussion on this subject is presented in Section IV.B.8. of the Final EIS 110/112.

(a) Equipment Locations

Table IV-6 illustrates locations of oil spill equipment in the Gulf of Mexico for all three planning areas. At the time of this writing, all operators with permits to drill or applying for permits are either members of Clean Gulf Associates (CGA) or have applied for membership. CGA is a cooperative of 87 oil and gas producing companies that operates in the Gulf. Established in 1972, its purpose is to acquire and maintain state-of-the-art oil spill recovery and cleanup equipment for the use of member companies. CGA has five general types of equipment -- fast response open-sea skimmers systems, high volume open-sea skimmer systems, shallow water skimmer systems, communications equipment, and boat and helicopter spray systems.

In the event that the discharger is unknown, the operator fails to cleanup, or cleanup activities are inadequate, the Coast Guard has Basic Ordering Agreements (BOA's) with local cleanup companies throughout the Gulf. These companies are used on a rotational basis. For large spills, the Gulf Strike Team, located in Mobile, Alabama, is available upon request by the on-scene coordinator.

Table IV-6

Availability of Oil Spill Cleanup

	Texas	Louisiana	Alabama	Florida
Clean Gulf Associates Cleanup Equipment Locations	Corpus Christi Port Aransas Fulton Texas City Galveston	Cameron Intercoastal City Metairie Houma Grand Isle Marrero Venice	Theodore	Panama City
Coast Guard BOA's Cleanup Equipment Locations	Brownsville (2)* Corpus Christi Galveston (3) Houston (3) Port Isabel Port Arthur (2) Port Neches	Harvey Reserve Berwick Morgan City (3) New Orleans (3) Belle Chasse	Mobile (2)	Panama City (2) Miami (2) Port Everglades Odessa Tampa (3) Mulberry Maderia Beach
Gulf Strike Team			Mobile	

*Number of companies.

Sources: Clean Gulf Associates, Operations Manual.
U.S. Dept. of Transportation, Coast Guard, Eighth District, Contract Personnel.
U.S. Dept. of Transportation, Coast Guard, Marine Safety Officer, Miami FL.
U.S. Dept. of Transportation, Coast Guard, Marine Safety Officer, Tampa, FL.

(b) Equipment Effectiveness

A wide variety of equipment is available to aid in the containment and cleanup of spilled oil. Current designs allow for cleanup operations in various stages. In some situations, however, it has proven beneficial to use cleanup personnel as opposed to mechanical equipment for cleanup operations. Containment and cleanup operations are labor intensive operations due to the complexity of the environment they are conducted in and the constant monitoring/planning efforts associated with them. Not only are these operations labor intensive, but the personnel must be well-trained in the use of equipment and the methodology of spill containment and cleanup. The most common products used for oil spill control and containment are such devices as booms, skimmers, sorbents, spill control chemicals (dispersants), and pumps.

The effectiveness of a containment/cleanup operation in an inshore area largely depends on the unique physical characteristics of the environment and the area of the operation. Because of this dependence on outside factors, the range of effectiveness varies from marginally successful to successful. For a more detailed discussion of cleanup equipment, see Section IV.B.3. of Final EIS 110/112.

l. Anchoring

Anchors and their chains or cables from support boats and ships, floating drilling units, and pipeline laying and other construction vessels disrupt a great deal of bottom in an area covered by soft sediment. Bottom-dwelling organisms can be smothered by the displaced sediment. Increased turbidity resulting from anchors and their chains or cables can temporarily clog the respiratory organs of many marine organisms and the bottom-feeding mechanisms of others. This increased turbidity is a short-term phenomenon and is usually not significant beyond a few hundred meters from the site of anchoring.

Anchors also do a great deal of damage to corals. The area actually affected will depend on depth of water, length of chain, size of anchor and chain, wind, and current. Anchor damage includes crushing and breaking of coral heads. Anchoring often destroys a wide swath of sessile organisms when the anchor is dragged or the vessel swings at the anchor causing the anchor chain to drag the seafloor.

Continental Shelf Associates (CSA) documented the damage caused by a single anchoring incident at the East Flower Garden Bank. The vessel involved was a tug with an attached barge. The predominant area of impact was approximately 3 m wide and 61 m long. Beyond this band, CSA observed intermittent impact in a band extending an additional 122 m. Initially, CSA attempted to count the individual coral colonies impacted; however, they abandoned the count after 200 colonies within 61 m. Mechanical damage to the coral colonies occurred with varying degrees of severity. Slight abrasions of the tissue were widespread. A more severe impact was the complete removal of coral tissue. Finally, the most severe damage resulted from the anchor cable which caused sawing coral heads in half, severing heads from their attachment points, and deep gouges and fractures. Relatively minor impacts can lead to more severe effects due to the introduction of disease or algal infections into the damaged coral tissues. These infestations can lead to mortality of the entire colony (CSA, 1984).

m. Platform Removal or Relocation

As discussed in Section IV.A.3.f., substantial subsidence can occur as a result of sulphur mining. For this reason, production platforms in the area may need to be relocated or raised one or more times during the life of the mine. Historically, the most common method of structure removal has been by either mechanical cutting or the use of explosives.

Removal of structures utilizing mechanical cutting would be expected to have a negligible impact on the resources of the area, while impacts as a result of explosive removal could be considerably higher. Recent strandings of sea turtles and marine mammals have prompted the MMS to initiate consultation with the NMFS in accordance with Section 7 of the Endangered Species Act for each scheduled explosives-related structure removal in the GOM. Mitigative measures developed as a result of Section 7 Consultation would be expected to substantially reduce impacts to endangered and threatened species as well as to the other resources of the GOM (USDI, MMS, 1986). Refer to Final EIS 110/112 and the Programmatic Environmental Assessment/Structure Removal Activities/Central and Western Gulf of Mexico Planning Areas (USDI, MMS, 1987a) for additional information on structure removals.

B. ITEMS OF SPECIAL CONCERN

1. Hazardous Conditions

Within the Gulf of Mexico major geohazards to offshore development are associated with seafloor geologic features which result in seafloor instability. These hazards present many operational limitations to the exploration and development of mineral resources. Seafloor instabilities present limitations and necessitate adaptations in the siting, structural engineering, and routing of pipelines, exploratory drilling and production platforms. Three conditions prevail in the Gulf of Mexico which cause unstable conditions on the seafloor: (a) salt movement which may result in salt domes, faults, steep slopes, gas seepage, and sediment slumping; (b) sediment overloading and differential compaction causing growth faults and differential subsidence; and (c) rapid sedimentation in deltaic areas that results in unconsolidated, fine-grained, often gas-charged sediments.

Most structures and equipment used for minerals exploration and development can be designed to withstand the stresses of the continental shelf environment if adequate information is available. Studies developed under the former BLM's Environmental Studies Program have been especially directed toward areas where more detailed geologic information was needed for intelligent management of the OCS mineral leasing program. Visual No. 5 shows the areas where geologic studies have provided detailed information and mapping.

For greater detail of potential geohazards existing within areas of the Gulf of Mexico, see Volume 1, Section III.A.1. of the Final Regional EIS.

Under the schedule for sulphur leasing, the offering of 153 blocks within the CPA does not allow for presale geohazard block evaluations that were previously done. Instead, the Secretary of the Interior has announced that geohazard surveying and evaluation will be done by industry. The Regional Director (RD) of MMS will notify the lessee through NTL 83-3 that such conditions exist that precautions in site selection and design must be taken. Thus, industry has the responsibility to interpret in detail and furnish the RD with the results of surveys for the blocks leased within the geohazardous areas. Subsequently, industry must indicate to the RD how plans of exploration and development minimize and/or avoid the geohazards which exist within the lease area. G&G activities authorized under 30 CFR 251 must be conducted so that the activities permitted do not create hazardous or unsafe conditions. G&G activities provide data on potential geological and man-made hazards. Geophysical surveys conducted on a lease must be conducted in compliance with NTL 83-3, Shallow Hazards Requirements for the Gulf of Mexico OCS Region. Prior to the installation of any structure or pipeline, the grantee shall conduct a shallow hazard analysis in the immediate area of the proposed activity to locate, identify, and assess the potential geologic hazards and engineering constraints that may be present (see Section I.B.2.b.(3)(a)).

The NTL and applicable letters to the lessee serve as guidance for minimum requirements and in no way restrict the authority of the RD to impose additional requirements on the lessee when necessary.

2. Blowouts

During drilling operations on the OCS, blowouts are the incidents that are most feared and have the greatest potential for causing the greatest number of deaths, injuries, property damage or loss, and pollution. A blowout is considered a complete loss of well-control.

Gas pressure can be responsible for a well blowout. Very shallow gas may occur in unconsolidated sediments at depths of 100-500 ft below the mud line. Drilling through these shallow natural gas zones requires extreme caution. A delicate balance between drilling-mud pressure and formation pressure is necessary to prevent an influx of gas into the wellbore and not fracture the near-surface formations. Shallow gas and formation fracturing is an even greater potential hazard in deep waters because it is more difficult to keep in proper balance with the ocean water and overburden pressures.

When a well blowout occurs, the loss of control could be momentary and control could be immediately regained using standard onsite safety equipment and procedures, or it may continue for several days. The duration of blowouts that occurred in 1979 through 1984 ranged from immediate shut-in to 57 days to regain control. The amount of pollution per blowout ranged from 1-64 bbls (Table IV-7). Since 1970 no oil spill of 1 bbl or more has occurred as a result of a blowout during drilling operations. In addition, the amount of oil pollution during blowouts

Table IV-7

Blowouts in the Gulf of Mexico, 1979-1984

Year	Drilling, Exploration, and Development	Nondrilling, Completion, Production, and Workover	Total Blowouts	Pollution	Deaths/Injuries	New Wells Started
1979[1]	5	0	5	0	8/9	1,109
1980[1]	4	4	8	1 bbl*	5/39	1,079
1981[1]	3	7	10	65 bbls*	7/4	1,106
1982[1]	4	4	8	0	0/7	1,155
1983[2]	8	3	11	0	0/2	981
1984[2]	3	1	4	0	4/3	1,163

*Occurred as a result of a nondrilling event.

[1] Fleury, 1983.
[2] Minerals Management Service Events File and Quarterly Reports, 1983 and 1984.

For information on blowouts prior to 1979, see U.S. Geological Survey Open File Report 80-101 (Danenberger, 1980).

has been decreasing. The amount of gas escaping during a blowout is difficult to determine; however, no identifiable environmental damage was caused by blowouts from 1979-1984.

Industrial expertise in safety has been increasing as industry has advanced drilling technology. MMS is supporting studies on blowout prevention, blowout fire suppression, and the collection of blowout oil before it disperses into the open ocean. An important factor in ensuring that offshore drilling operations are carried out in a manner which emphasizes safety of operations and minimizes the risk of environmental damage is the proper training of personnel in pollution prevention procedures. The enacted Safety Device Training Program requires all personnel to receive training for the installation, testing, inspection, and operation of production, safety, and pollution prevention equipment. The Well-Control Training Program, instituted by MMS in 1979, requires all personnel involved in offshore drilling activities to be trained in well control operations and has requirements for periodic refresher courses. These programs will be applied to sulphur operations, where applicable, through the MMS permitting process.

The sulphur industry has a long history of drilling around salt domes. They are familiar with the inherent dangers in this activity. Several blowouts have occurred onshore. At the Garden Island Bay Mine, three rigs were lost, one thrown on its side, and one burned while drilling for sulphur. High pressure gas encountered at three levels was the cause (Haynes, 1959). The sulphur drilling crews have learned from their experiences with such dangers and use blowout preventers and diverters as required by MMS in OCS Order No. 10, in order to provide maximum safety and protection to the environment during drilling operations.

C. ENVIRONMENTAL IMPACTS OF THE PROPOSED ACTION AND ALTERNATIVES

1. Impacts from Alternative A - The Proposed Action

a. Impacts on Sensitive Coastal Habitats

(1) Barrier Beaches/Islands

For a description of the morphology and sensitivity of barrier beaches/islands in the vicintity of the proposed action see Sections III.B.1.a. and IV.D.1.a.(1)(a) of Draft EIS 113/115/116. The barriers are depicted on Visual No. 4 and levels of impacts are defined in Table S-3.

Impact Analysis

The major impact producing factors related to the proposed action which could potentially affect the Gulf's barrier beaches include pipeline emplacement, support infrastructure construction, navigation canal construction and maintenance, sulphur spills, oil spills resulting from interference with oil production facilities, and discarded trash and debris. The latter topic is discussed in Section IV.C.1.j.

No pipelines are expected to be constructed for the transport of produced sulphur to shore; however, it is possible that up to two small pipelines may be constructed for the purpose of supplying fresh water and fuel gas to potential production sites within close proximity to land. The locations of the blocks available for lease that may be supplied by these pipelines indicate that potential landfalls will be along the Louisiana shoreline between Southwest Pass and Atchafalaya Bay. This is an area experiencing significant coastal barrier erosion and the loss of important wetlands habitat landward of the barriers.

The sensitivity of the area in question plus the current efforts of the State of Louisiana to stabilize its coastal barriers, makes it unlikely that pipeline emplacement through a barrier would be allowed. If there were no alternatives and both pipelines were routed across barrier islands/beaches, an estimated 20 acres of the resource would be altered. This represents less than 0.02% of the area of the barriers in the region.

The most common technique of pipeline installation used on coastal barriers is the pull method (described in Section IV.D.1.a.(1)(a) of Final EIS 110/112). The construction trench would result in short-term, localized changes; however, that part of the trench that is cut through the dune ridge could create an area of disturbance that might leave the barrier more vulnerable to potential breaching during storms. The dune ridge is an area of potential instability in the landform/vegetation complex that is often difficult to restore. Long-term adverse impacts to the area can be reduced significantly through the implementation of rigid construction practices, proper scheduling, the employment of mitigation measures, and the restoration of the dune system.

No new ancillary facilities or new navigation canals are expected to result from the proposed action. Maintenance dredging of existing navigation canals will occur periodically and this in itself interferes with the dynamics (littoral system) of coastal barriers, endangering the natural deposition of sand/sediment and maintenance of the barriers. The negligible incremental increase (less than 0.05%) in the use of navigational channels as a result of the proposed action will have an insignificant effect on the amount of dredging required.

The only way a sulphur spill would affect a barrier island/beach is if a vessel transporting sulphur were to spill its cargo near or directly on the beach. The chance of such an accident is relatively unlikely; however, if such an event occurred the impacts would be localized and temporary. The major impact would be loss of beach sand removed with the sulphur during cleanup activities. This is of particular importance in the areas of severe erosion along the barrier beach network of south Louisiana.

Oil spills present a variety of threats to coastal barriers, most significant of which is the potential for high to very high impacts that could result from the removal of extensive amounts of beach sands during oil spill clean-up activities. Oil spill cleanup would likely encompass a much larger area than that for a sulphur spill due to the spreading nature and ease of transport of surface oil slicks. Oil spills associated with the proposed action are a possibility because of the close proximity of oil production activities to the areas being offered for the leasing of sulphur. However, the mitigating measures (Section II.A.3) sufficient to prevent use conflicts between these activities and will be applied to all leases awarded.

Conclusion

The short-term nature and relatively small area of disturbance expected to result from the emplacement of pipelines and the minimal probabilities of any sulphur spill or oil spill contacts indicates that the impacts of the proposed action on barriers beaches/islands will be very low.

Cumulative Impacts

Impact producing factors that contribute to the cumulative degradation of coastal barriers include those associated with State and Federal offshore minerals activities (pipeline emplacement, support infrastructure construction, oil spills, navigation canal construction and maintenance, and discarded trash and debris) and man-induced and natural factors including coastal development, beach protection and stabilization activities and construction, alteration of land use, recreation activities, hurricane and storm disturbances, and erosion and land loss. The latter is by far the most significant. Land loss in coastal Louisiana is exceeding 50 mi^2/yr, and preservation of Louisiana's barriers and shorelines has become a matter of increasing concern. These barriers serve to protect the State's vast interior wetlands from direct attack from storm waves and saltwater intrusion. Between 1880 and 1980, the total coastal barrier area decreased from 98.6 km^2 to 57.8 km^2, an overall loss of 40% (Penland and Boyd, 1982).

The three primary causes of coastal barrier erosion and land loss include: reductions in sediment supply, relative sea-level rise, and human activities. Although listed separately, the third category directly affects the other two. Of foremost importance is the natural decrease in sediment supply that accompanied climatic changes over the past few thousand years. The major coastal rivers and nearshore currents are no longer delivering the volume of sediment that they once did. This natural decrease in sediment supply has been aggravated to varying degrees by dam construction and entraining of rivers, and emplacement of jetties, groins, and seawalls that compartmentalize the coast and disrupt the longshore transport of sand. These structures have locally contributed to shoreline erosion and their contribution to land loss may be even greater in the future (Morton, 1982).

Relative sea-level rise refers either to rising of the water level or sinking of the land surface; both processes produce the same effect and both may act simultaneously, with the end result being that the land becomes submerged and the shoreline retreats inland. Along the Texas and Louisiana Gulf Coast relative sea-level rise in recent years averaged between 0.5 and 1 m per century (Hicks, 1972). Again, both natural processes and human activities are involved.

There are two approaches to beach protection and shoreline stabilization: rigid structures, such as jetties; and nonrigid techniques, such as artificial beach nourishment. The rigid devices fall into two basic categories: structures to trap longshore transport of sand (e.g., groins and jetties) and structures to prevent the erosion of the shoreline (principally with seawalls). Groins, seawalls, and other engineering devices are designed to impede natural oceanic currents and sand transport. Due to the high cost of emplacement, these rigid structures are used only in localized areas to protect urbanized development in hazardous areas (Leatherman, 1982).

Rigid engineering structures have often produced poor and, in some cases, deleterious results. Large amounts of money have been spent on structures designed to save the beach, but many are ineffective and some have aggravated existing problems. Most concrete shoreline protection structures erected on the Gulf Coast in recent years have failed or have been severely damaged. These structures have finite lives, are expensive to construct and maintain, and commonly transfer the erosion problem elsewhere by locally eliminating the sediment supply. Nonrigid techniques do not interfere greatly with natural processes, although there are some problems associated with dune stabilization (Morton, 1982).

Artificial beach nourishment is probably the most effective way to deal with beach erosion problems. Sand is supplied to the beach at the same rate that it is naturally being lost alongshore or offshore. The problem is in being able to locate nearby sources of unpolluted sand of the correct size. At any rate, attempts to stabilize highly dynamic barrier islands will ultimately fail as the sea level continues to rise. While engineering structures may be successful in localized areas for the short term, long-term problems are ultimately created, and substantial, continuing maintenance costs are incurred with this approach.

In spite of inherent hazards, there has been a boom in barrier island construction during the past few decades. A recent USGS study showed that urbanized land on barrier islands increased 152% between 1950 and 1973. When stable features such as buildings and roadways are built on dynamic surfaces in highly vulnerable positions, heavy damage can result from direct wave attack, overwash, and flooding. The leveling or relocation of the barrier dune reduces the island's resiliency to oceanic forces. As the barrier retreats, these stable structures face the impact of the high energy swash/surf zone (Leatherman, 1982).

Recreational pressures on coastal ecosystems have greatly increased as well. The impacts include pedestrian trampling and off-road vehicle (ORV) traffic; the degree of impact depends upon the type of use and susceptibility of the system being affected. Each natural system has its own level of tolerance, and this sensitivity must be determined in order to devise management strategies for alleviating or minimizing impacts. Most coastal ecosystems are adapted to severe environmental conditions and are not fragile in the usual sense. Stresses to these ecosystems include large variations in temperature, salinity, moisture, burial by sand, and saltwater flooding. These ecosystems are fragile only in the sense that the new stresses being applied by man are too severe (Leatherman, 1982).

The impact of natural events (storms and hurricanes) on natural resources is often overlooked due to the focus on economic losses resulting from these events. In 1985, three hurricanes severely damaged Louisiana's coastal barrier systems and shorelines. Hurricane Elena (September 1985) caused severe erosion and land loss along the Chandeleur Islands, where approximately 20% of the land area was lost. Elena eroded 25-80 ft of beachfront and breached the islands in several locations there. Hurricane Danny (August 1985) eroded approximately 10%-15% of the Isle Dernieres and cut several tidal channels through these islands. Beaches were eroded some 30-100 ft along these islands. Timbalier Island incurred similar damage to its shoreline. Grand Isle experienced erosion of 20-60 ft of beachfront. Hurricane Juan (October-November 1985) caused the heaviest damage to the State's barriers and shorelines by making landfall and lingering off/on the Louisiana coast for three days, resulting in extensive land loss and loss of fish and wildlife habitat. Beaches eroded 40-100 ft along the entire coastline, with some areas experiencing more extensive loss of beachfront. Channels through the barrier islands were widened and numerous new inlets were created (Louisiana Geological Survey, 1985).

The contribution of the proposed action to the cumulative impacts on coastal barriers is expected to be very low to nonexistent, but the fact remains that the barriers of coastal Louisiana may not survive the onslaught of other natural and man-induced impacting factors.

Conclusion

The overall expected level of cumulative impact to barrier beaches/islands is estimated to be very high.

(2) Wetlands

The wetlands considered in this analysis include forested wetlands, nonforested wetlands or tidal marshes, and mangroves (Visual No. 4).

Impact producing factors resulting from the proposed action which could adversely affect wetlands are sulphur spills, oil spills, pipeline placement, dredging, and construction of onshore facilities in wetland areas (Sections IV.A.3. and IV.B. of Draft EIS 113/115/116). Each of these factors are considered in the impact analysis, and an overall expected level of impact is estimated for the coastal area using the five levels of impact as previously defined (Table S-3).

Impact Analysis

Cameron, Vermilion, Iberia, St. Mary, Terrebonne, Lafourche, Jefferson, Plaquemines, St. Bernard, Orleans, and St. Tammany Parishes contain nonforested wetlands that could be exposed to potential sulphur spills or secondary oil spills (Visual No. 4). A sulphur spill occurring and contacting a wetland area is likely to impact a relatively small area. The liquid sulphur would solidify and require eventual removal by mechanical means. The spill itself and subsequent removal would only impact a localized area, estimated to be up to 1 or 2 acres. An oil spill coming into contact with wetlands could cause devastating and relatively long-term damage (1-3 years). Important variables determining the degree and impact include the amount and toxicity of the oil, the degree of weathering the oil has undergone prior to contacting a wetland, wetland type contaminated by the oil, the climate and weather of the spill site, the water depth and suspended sediment load, the cleanup method attempted, and previous exposure to oil spills. The chance of an sulphur spill or secondary oil spill occurring and contacting wetlands in Louisiana as a result of this proposal is very unlikely. Terrebonne, Lafourche, and St. Bernard Parishes contain mangroves which could be exposed to potential sulphur or secondary oil spill spills (Visual No. 4). The chance of an sulphur spill or secondary oil spill contacting Louisiana seagrass area is very low.

Up to 2 pipeline landfalls (small diameter gas and water lines) and up to 20 miles of onshore pipelines could be constructed in the Central Gulf coastal area as a result of the proposed action. Some maintenance dredging of existing navigation channels will be required. This coastal construction/dredging could damage or destroy up to 45 acres of Louisiana wetlands. However, it is expected that existing facilities will be utilized as much as possible and any new facilities will be located so as to have a minimal impact on coastal wetlands. No new navigation canals are expected to result. Maintenance dredging of existing navigation canals occurs periodically; the amount associated with offshore sulphur activities cannot be quantified. However, dredging does cause extensive damage to wetland areas and is discussed further under cumulative impacts. Wave action generated by barge/vessel traffic in navigation canals also causes soil erosion and loss of wetlands.

Conclusion

As a result of the proposed action, the level of impact on coastal wetlands is expected to be very low.

Cumulative Impacts

This cumulative analysis considers the effects of impact producing factors related to the proposed action plus those related to prior, proposed, and future OCS oil/gas activities, other governmental and private projects/activities, and pertinent natural processes and events that may occur and adversely affect wetlands in the same general area that may be affected by sulphur activity located in the CPA. Specific types of impact producing factors considered in the analysis include construction of onshore support facilities, sulphur spills, oil spills, canalization, land development, and miscellaneous factors.

Wetlands loss has been and continues to be of concern in many areas of the central Gulf Coast. In the Mississippi Deltaic and Chenier Plains of Louisiana, the rate of wetlands loss is very high. Gagliano (1981) estimated that the annual wetlands loss in 1980 in the Mississippi Deltaic Plain of Louisiana was 39.4 square miles (25,216 acres). During the period 1952-1974, the average annual rate of wetlands loss in the Chenier Plain was estimated at 7.7 square miles (4,928 acres) (Gagliano et al., 1981). The current estimated collective rate of wetlands loss for the Mississippi Deltaic Plain and the Chenier Plain is 50 square miles (32,000 acres) per year (Boesch et al., 1983).

The impacts of canals on coastal wetlands include both direct and indirect impacts. The direct loss of wetlands associated with oil and gas development results from dredging activities, dredged material disposal, and canal widening. Indirect losses result from hydrologic changes that develop in wetlands after canalization has occurred. Turner et al. (1982) estimated that canals accounted for 2.4% of the CPA coastal area in 1978. The cumulative linear extent of canals was estimated at 4,573 miles in 1970 (Barrett in McGinnis et al., 1972) and 6,100 miles in 1984 (U.S. Dept. of the Army, Corps of Engineers, 1984), an increase of about 1,527 miles of canals in 14 years. Canals widen through use, generally as a result of wave action from vessel traffic and altered hydrologic patterns. According to Craig et al. (1979), the annual increase in canal width ranges from about 2%-14% per year for a doubling time of 5-60 years. Variability in widening rates is associated with firmness of the marsh substrate and the amount of traffic in the canal (Johnson and Gosselink, 1982).

Indirect impacts of canalization affecting wetlands loss include hydrologic interruptions and saltwater intrusion. Scaife et al. (1983) indicate that hydrologic interruptions created by spoil banks are a primary factor affecting wetlands loss. Intersecting spoil banks partition areas of marsh and impede drainage. Poor drainage is deleterious to plant survival (Mendelsohn et al., 1981), and as vegetation in impounded areas dies, ponds appear.

Canals act as conduits for the inland movement of saline water. Saltwater intrusion kills salt intolerant plants, thereby contributing to wetland deterioration. Saltwater intrusion is damaging to freshwater wetlands, especially to "flotant marshes" which lack a firm subsoil and consist entirely of salt intolerant vegetation. Plant species in brackish marshes can tolerate higher salinities and may not be severely damaged by an increase in ambient water salinity.

Estimates of the contribution of canalization to wetlands loss vary. Turner et al. (1982) estimates that 10% of the coastal land loss in Louisiana is caused by the direct impacts of canals and as much as 80% by indirect impacts. Most estimates of wetlands loss from direct and indirect impacts combined range from 12%-65% (Manning, 1972 in McGinnis et al., 1972; Deegan et al., 1979; Gagliano, 1973; Craig et al., 1980; and Scaife et al., 1983).

Development of wetlands for agricultural, residential, and commercial uses is a major factor affecting wetlands loss in Louisiana. During the period 1952-1974 in the Chenier Plain region of southwestern Louisiana, an estimated 3,045 acres of wetlands was converted to urban use (Gosselink et al., 1979). During the period 1956-1978, an estimated 132,034 acres of urban/industrial development occurred in the Mississippi Deltaic Plain region of southern Louisiana (Bahr and Wascom, 1984). Coastal storms and hurricanes also cause severe soil erosion and loss of wetlands.

Miscellaneous secondary factors, including marsh burning, marsh buggies, onshore oil and gas activities, well site construction and brine disposal, affect wetlands loss. Recent studies (Bahr and Wascom, 1984) report major marsh burns that resulted in permanent wetlands loss. Sikora et al. (1983) reported that in one 16 km^2 wetland area in coastal Louisiana, an alarming 18.5% of the area was covered with marsh buggy tracks. Well site construction activities involve board roads and ring levees. Ring levees are approximately 4-acre impoundments constructed around a well site. McGinnis et al. (1972) estimated that between 1950 and 1971, 20,442 well completions were made in coastal Louisiana. By 1984, the total number of wells drilled in the coastal parishes had increased to approximately 41,000, a 101% increase in 13 years (USDI, GS, 1984). Brine disposal associated with oil/gas exploration/production may have a significant local impact on wetlands near well sites.

About 11.6 (1,000 bbls or greater) oil spill contacts with coastal land segments (parishes and counties) are estimated as a result of Federal OCS activity and from crude oil tanker imports (USDI, MMS 1987). The extent of damage to wetlands from an oil spill depends on many factors (Section IV.B.). The majority of the oil spills which have occurred along the Gulf coast have not affected large areas of wetlands. Occasionally, small areas along the shoreline are contacted; however, an onshore oil pipeline break may affect larger areas (up to 100 acres) due to topography and drainage patterns. Cumulatively, as well as individually in some cases, oil spill contacts are likely to cause considerable destruction and severe alteration to coastal wetlands, resulting in a high level of impact.

Cumulatively, Federal OCS oil/gas-related activity is estimated to result in the following new onshore construction: 7 service bases, 13 pipeline landfalls, 180 miles of onshore pipelines, 4 pipeline storage and coating yards, 5 platform fabrication yards, and 5 gas processing plants (USDI, MMS, 1987b). Cumulatively, Federal OCS sulphur-related activity is estimated to result in the following new onshore construction: 2 pipeline landfalls, 20 miles of onshore pipeline, and 2 possible expansions of existing marine terminal storage facilities. If all these onshore facilities are constructed, it could require a total of about 3,015 acres for oil/gas activities and about 20-30 acres for sulphur activities in the Central Gulf coastal region. It is not expected that all of this construction would occur in wetland areas; however, an undetermined amount of wetlands would probably be affected.

Conclusion

The overall level of cumulative impact on coastal wetlands in the Central Gulf is estimated to be very high.

b. Impacts on Sensitive Offshore Habitats

Many of the potential impacts associated with sulphur exploration, development, and production operations are the same as those associated with oil and gas activities. These are summarized below. For details of such activities and impacts, see final EIS 110/112 (USDI, MMS, 1986), especially pages IV-94 through IV-107.

The topographic features and "live bottom" areas of the Gulf are offshore habitats sensitive to several impact producing factors related to offshore exploration, development, and production activities. The potential impact producing factors include blowouts, anchoring, structure emplacement, and effluent discharge.

Blowouts can occur during the drilling of a sulphur well (Section IV.B.2.). Blowouts can result in large amounts of bottom sediment being thrown into the water column. These sediments fall back to the seafloor and can affect the organisms living there. Blowouts are relatively rare accidents. Small amounts of petroleum hydrocarbons may be released during a blowout. Oil spills may occur at the surface due to tanker spillage or at the seafloor due to a well blowout. Surface spills could discharge large amounts of either crude or refined oil for a short period of time. Both surface and subsurface spills could result in a steady discharge of oil over a long period of time. Such release of oil into the marine environment from sulphur operations is not expected. These types of accidents are rare in the Gulf.

Anchoring of pipeline lay barges, drilling rigs, or work boats and structure emplacement (pipeline, drilling rig, or platform emplacement) result in physical disturbance of the benthic environment. These activities are routine operations of exploration and development and are unavoidable.

Drilling muds and cuttings discharges result in localized water turbidity, deposition on the surrounding seafloor, and potential effects of the low concentrations of toxic constituents. Drilling discharge is also a routine operation in exploration and production activity.

A sulphur spill may occur during the operations resulting from this proposal. Such a spill would cause minimal damage.

Subsidence of the seafloor may occur if producible quantities of sulphur are discovered as a result of this proposal. Subsidence is normal in sulphur operations and is the main reason the blocks containing sensitive biota of the topographic features are not being offered for lease.

The impact producing factors are discussed more thoroughly in Section IV.A.3.

(1) Topographic Features

Impact Analysis

None of the 16 topographic features of the Central Gulf are near enough to blocks offered in this proposal to be affected by activities resulting from this proposed sulphur sale. Indeed, all such resulting activities will take place landward of the sensitive habitats, so even accidents occurring during the transportation of sulphur to shore (such as a sulphur spill over a sensitive habitat) will not affect these habitats.

Conclusion

None of the impact producing factors mentioned above will affect sensitive offshore habitats as a result of this proposal; impacts are thus expected to be very low.

Cumulative Impacts

This cumulative analysis considers the effects of impact producing factors related to the proposed action plus those related to prior and future OCS oil and gas sales, tanker and other shipping activity, commercial fishing, recreational fishing and diving, treasure hunting, and natural occurrences that may occur and adversely affect topographic features. Specific impact producing factors considered in the analysis include drilling rig, platform, and pipeline emplacement; well drilling (discharges); hydrocarbon production (produced waters); blowouts; oil spillage; anchoring; operational discharges from tank ships; and hurricanes.

Oil and gas leasing has been increasing around the topographic features of the Central Gulf, and this trend is expected to continue in the future. Recent leasing near the banks has resulted not only from interest in "virgin" blocks but also from the releasing of expired or relinquished lease blocks. Many oil and gas operations on the previously leased blocks are subject to the provisions of the biological stipulation. These operations are not expected to have an adverse impact on the biota of the topographic features. Thus, the impact from cumulative oil and gas routine operations would be limited to the impacts from the operations conducted as a result of the proposed action and future OCS sales. These impacts as discussed above are estimated to be very low.

Increased leasing near topographic features increases the probability that a blowout or seafloor oil spill may occur in proximity to a feature. Blowouts and seafloor oil spills are extremely rare in the Gulf, and the probability that the spill or suspended sediments would reach a bank is even less.

Anchor damage is considered to the most serious threat to coral and coral-community areas (Bright and Rezak, 1978 and Rezak and Bright, 1981). The biological stipulation on the existing leases prohibits the anchoring of industry-related vessels in the No Activity Zones; the stipulation does not affect other activities such as tankering, fishing, or recreational SCUBA diving nor would it prohibit industry-related anchoring in other blocks. No data are available on the extent to which such anchoring may take place; however, all three activities are known to occur in proximity to the topographic features.

Banks are well-known fishing areas, and several are SCUBA trip destinations. Anchoring at a topographic feature by a vessel involved in any of these activities would cause significant damage to the biota, although the degree of damage would depend on the size of the anchor and chain. Anchoring at the banks may diminish as the shipping industry becomes aware of the damage their anchors do to the biota of the banks. However, there is potential for serious anchor damage to the biota of topographic features despite the regulations in place and proposed.

Impacts to the topographic features could occur as a result of operational discharges from tankers. Due to the dilution factor and the depths of the banks, this activity is not expected to have a high level of impact on the topographic features.

Impacts from natural occurrences such as hurricanes are not expected to result to the banks. An industry-funded monitoring effort was underway at the Flower Garden Banks during the passage of Hurricane Alicia directly over the banks. The results of this study showed no effect on the biota of the bank due to Alicia.

Conclusion

The level of cumulative impact to sensitive habitats of topographic features is estimated to be very low, assuming that the biological stipulation continues to be applied to oil and gas leases near the features.

(2) Live Bottoms

The definitions used to describe the expected level of impact to the live bottom areas resulting from the proposed action are defined in Table S-3.

Impact Analysis

The live bottoms of concern in the Central Gulf are associated with the pinnacle trend area. The pinnacle trend is located between 240-330 ft water depth in the Main Pass and Viosca Knoll lease areas. The pinnacles are scattered in this band. Live bottom areas are sensitive to drilling activities. For this reason leases in past oil and gas sales have contained a live bottom stipulation. Since none of the blocks of the pinnacle trend are offered in this sale, and since the only impact producing factor resulting from this proposal likely to impact the pinnacles is structure emplacement, there will be no impacts to these areas as a result of this proposed sulphur sale.

Conclusion

There will be no impacts to these areas as a result of this proposed action.

Cumulative Impacts

Cumulative impacts described for topographic features above would be essentially the same for live bottom areas. Live bottom areas may, however, be more susceptible to storm-induced damage due to sediment movement since they exhibit lower relief than topographic features.

Conclusion

Cumulative impacts to live bottom areas are expected to be very low, assuming that the biological stipulation continues to be applied to oil and gas leases near these features.

c. Impacts on Water Quality

The five impact levels will be used in the following analysis of potential impacts on offshore water quality are defined in Table S-3.

Varying degrees of water quality degradation could occur as a result of sulphur mining operations in the Gulf of Mexico. Wastes from these activities are varied and may be transformed chemically, biologically, or radioactively when introduced into the marine environment. These wastes may be dissolved and form new substances or be mixed vertically and horizontally in the water column by small-scale motions or large-scale currents, and they may fall into the bottom sediments or be recycled by these same processes. This series of transformations or chemical reactions will govern a waste's transport through the water column and its toxicity to marine organisms. The bio-effects may be on individual organisms or whole ecosystems, with long-term effects such as changes in reproductive habits or genetic make-up of species. The method of delivery to the environment as well as the intrinsic chemical properties of each source will influence a waste's distribution throughout the Gulf.

Due to the complexity of these waste movements and behaviors, several parameters are needed to determine their extent of impact. Specification of point source functions, the form of the waste, rate of release, frequency of disposal, and geographical location of disposal are parameters essential in determining the extent of impact on water quality in any given area (Workshop . . . 1979). Also important are the areas impacted, the duration of impact, and the period of recovery. Potential water quality degradation resulting from sulphur mining operations will be governed by several factors which include the resuspension of bottom sediments through exploration and development activities, platform removal operations, and pipeline construction; the discharge of deck drainage, sanitary wastes, and domestic wastes; the discharge of bleedwater; the discharge of drilling fluids and muds; accidental hydrocarbon discharges due to spills, blowouts, etc. These factors are more thoroughly discussed in Section IV.A.3.

Impact Analysis

Some 60 exploration/delineation wells, 324 development wells, 576 sidetrack wells, 3 mining complexes, and up to 40 miles of pipelines are estimated under the proposal. Under this scenario, the discharge of an estimated 4.25 million gallons per day per complex of bleedwater, 1.22 million bbls total of drilling muds, 137,040 yds^3 total of drill cuttings, and an average of 4,200 gallons per day of treated sanitary domestic wastes from platforms may be expected as a result of the proposed action. Pipeline-related activities would result in the disturbance of up to 240,000 yds^3 of sediment under the same scenario. Contaminants from marine transportation activities may enter the Gulf as a result of routine operational discharges. Activities consisting of supply boat and shuttle tankering trafficking in support of the proposed action would routinely discharge pollutants consisting of domestic waste products such as sewage, food waste, and trash or debris.

Immediate effects would be brought on by increased drilling, construction, and pipelaying activities, causing an increase in water column turbidities of the affected waters. Such increases would have a nominal impact on the productivity of phytoplankton, but may temporarily inhibit the respiratory and feeding mechanisms of numerous benthic and pelagic marine organisms within the area of construction. Pipeline construction activities may also result in the resuspension of some 240,000 yds^3 of sediment and settled pollutants, toxic heavy metals, and pesticides if present.

The discharge of an average of 4,200 gallons of treated sanitary wastes per day per platform may increase levels of suspended solids, nutrients, chlorine, and biological oxygen demand (BOD) in a small area near the point of discharge. However, as a result of treatment prior to discharge as is required through USEPA's NPDES discharge permitting program, when combined with seawater these constituents are quickly diluted.

During the course of exploration development and sidetrack drilling resulting from the proposed action, the discharge of drilling fluids, cuttings, and sand would degrade the quality of the waters surrounding the proposed new platforms. Drilling fluid/cutting discharges will be continuous or bulk. Some 1.22 million bbls of drilling muds and

137,040 yd^3 of drill cuttings are estimated to result from drilling activities associated with the proposed action. As with oil and gas operations, continuous discharges may come from the solids control equipment on each platform, while bulk discharges (commonly known as active mud discharges or mud tank dumps) are discharges of large volumes of fluids and cuttings (16-190 m^3), at rates of discharge (80-110 m^3/h) and lasting for a period of 20 minutes to 3 hours (Mors et al., 1982; Petrazzuolo, 1981). Concern has been expressed regarding the effects of drilling muds and cutting discharges on the marine environment. Based on the findings of NAS (1983), Symposium (1980), Neff (1981), Petrazzuolo (1981), Menzie (1982), and others, their results suggest that the environmental risk of exploratory drilling discharges to most OCS marine communities are small. More than 96% of the whole drilling fluids tested in short-term experiments are classified as "slightly toxic" or practically "nontoxic." Toxicity does not seem to be a problem at the concentrations of material found at distances greater than 200-500 m from the discharge point, and not at distances greater than 1,000 m. Much of the toxicity of the mud aqueous faction of drilling fluids appears to be attributable to volatile organic components, which may include petroleum hydrocarbons and by-products of lignosulfonate and lignite, whereas suspended solids may cause mortality in sensitive species and juveniles by clogging and damaging gill epithelia. Benthic infauna tend to be affected to the greatest extent by offshore drilling waste disposal, but most of the studies suggest that impacts are restricted to an area within 300-500 m of the discharge site. Although dilution is extremely rapid in offshore waters to the extent that every substance measured in the water column, including turbidity, is at background by a distance of 1,000-2,000 m, uncertainties regarding effects still exist for low energy depositional environments which experience large inputs of drilling discharges over long periods of time. For a more detailed discussion of drilling fluid/cutting discharges on the marine environment, see Section IV.A.3.a.

Bleedwater is by far the largest quantity of waste to be discharged during normal sulphur mining operations resulting from the proposed action. Up to 4.25 million gallons of bleedwater per day per complex are estimated to result from the proposed action. These waters will be discharged directly to the surface waters surrounding the bleedwater platforms.

Previous analytical results indicate that dissolved solids in typical bleedwater streams closely approximate those of typical seawaters. Sulfide in the bleedwater will have a very brief presence once discharged into the open sea due to rapid dissipation into the atmosphere, dilution, and oxidation. No measurable degradation of the marine environment is expected as a result of dissolved oxygen depression from bleedwater discharges. Based on years of tests by the Freeport Sulphur Company at the Grand Isle Mine, the data indicate that bleedwater is not detectable (measurable) at 300 ft from the discharge source. For a more thorough discussion of bleedwater, see Section IV.A.3.a.

Accidental spills of molten sulphur would have minimal impacts on water quality. At the temperature of molten sulphur (270° to 320°F), it is insoluble in water and is relatively inert with respect to the chemical constituents of sea water (see Section IV.A.3.e. and Appendix A).

Offshore water quality degradation will occur within the immediate vicinity of exploration and production sites with the highest impacts expected to occur within a few meters to tens of meters from the discharge source. These impacts, however, will decrease to very low with distance (500-1,000 m) from the source.

Conclusion

As a result of the proposed action, the impact to offshore water quality in the Central Gulf is expected to be low.

Cumulative Impacts

This cumulative analysis considers the effects of impact producing factors related to the proposed action plus those related to current sulphur mining operations, Federal OCS activities, State oil and gas activity, tankering and other vessel traffic, the Strategic Petroleum Reserve Program, and industrial waste disposal activities that may occur and adversely affect offshore water quality in the same general area that may be affected by OCS oil and gas activity located in the CPA. Specific types of impact producing factors considered in the analysis include well drilling discharges, pipeline emplacement, formation and bleedwater discharges, dredging, accidental oil spillage, routine operational discharges, ocean disposal of hazardous material, and industrial waste discharges.

Offshore water quality degradation in the Gulf of Mexico is associated primarily with effluent discharges by current offshore enterprises, consisting of OCS oil and gas activities and marine transportation sources. As of January 1983, some 15,871 wells had been drilled in Federal waters off Louisiana, while 1,695 wells were drilled off

Texas. Production from these wells equated to some 6 billion bbls of oil/condensate and 56.8 tcf of gas off Louisiana and 89 million bbls of oil/condensate and 5.2 tcf of gas off Texas (USDI, MMS, 1984d). Potential discharges associted with these past exploration/production activities equate to some 8.9 million yd^3 of drill cuttings, 79.9 million bbls of drilling muds, and up to 5.48 billion bbls of formation waters.

Offshore waters will, therefore, be subject to cumulative impacts from discharges of drilling fluids, formation waters, and other effluents which add burdens of both toxic and non-toxic materials to the water column. However, the natural processes of dispersion, degradation, and sedimentation will result in immeasurably low concentrations of these materials within a few meters to a few kilometers of the discharge site, resulting in low impacts.

The following discussion of other factors which may cumulatively impact offshore water quality has been taken from NOAA's National Marine Pollution Program Plan dated 1981 (USDC, NOAA, 1981).

Dredging of new channels and maintenance dredging of existing channels are required to provide safe and efficient navigation conditions for commercial and recreational marine transportation. Channel dredging generates significant amounts of dredged material consisting of the sediment and water mixture excavated from areas dredged. On the basis of volume, dredging is the largest single source of material that is ocean dumped. During 1979, more than 72 million cubic yards of dredged material was deposited in the marine environment (U.S. Dept. of the Army, Corps of Engineers, 1980). Of that total, 68% was disposed of in the Gulf of Mexico. The total constituted nearly eight times the combined tonnage of industrial wastes, sewage sludge, construction debris, and other waste materials disposed of in the marine environment during 1979 (U.S. Dept. of the Army, Corps of Engineers, 1980). Compared with other materials that are disposed of in the ocean, most of the dredged material excavated in the United States is relatively innocuous, in many instances containing no harmful pollutants and, in most of the remaining cases, containing only trace levels of contaminants. In these cases, the primary concern associated with disposal of the relatively innocuous materials centers around the direct physical effects of disposal. These physical effects include burial of organisms, increased levels of suspended sediments, and accretion of disposed materials (U.S. Dept. of the Army, Corps of Engineers, 1978). However, dredged material taken from highly polluted areas is usually contaminated with harmful chemical constituents such as heavy metals, synthetic organics, and oil and grease. Open-ocean disposal of these materials carries the threat of acute or chronic toxic effects on marine organisms, and potential contamination of human food resources. Much research has been conducted to describe the effects of dredged material disposal in the marine environment, and to evaluate disposal options that may be preferable to ocean dumping.

Industrial wastes may contain potentially harmful constituents including synthetic organics, heavy metals, and oil and grease. Commonly used disposal options for industrial wastes are secure landfills, ocean dumping, pipeline discharges to coastal and inland waters, and incineration. When industrial wastes are ocean dumped, the waste materials are barged to a designated disposal site and discharged. Between 1973 and 1978, some 2.6 million tons of industrial wastes were dumped into the Gulf of Mexico; however, there has been a trend toward reduction of total ocean dumping of industrial wastes since 1973 when ocean dumping became regulated by the Federal Government and industrial waste dumping has been totally eliminated in the Gulf of Mexico.

The first incineration at sea of chemical waste officially sanctioned in the U.S. occurred in the Gulf of Mexico between October 1974 and January 1975 when M/T Vulcanus incinerated 16,000 metric tons of organo-chlorine wastes at a designated site about 140 nautical miles southeast of Galveston, Texas (U.S. Environmental Protection Agency et al., 1980). In 1977, 17,600 tons of chemical waste were incinerated in the Gulf of Mexico. From studies of these early burns, it has been concluded that incineration at sea for organic chemical wastes does not cause unacceptable environmental consequences, at least on a limited basis for some chemicals and at these specific sites (U.S. Environmental Protection Agency et al., 1980). Candidate wastes for incineration at sea are generated primarily by the following industries: petroleum refining, organic chemical production, synthetic fibers and resins manufacture, and pesticides production. Although incineration at sea has been conducted on a limited basis, it is likely to become more common in the future. Increasing amounts of industrial waste are produced each year, and increased regulatory pressure through implementation of the Resource Conservation and Recovery Act (RCRA) is eliminating some of the traditionally used land-based disposal options because of potential environmental hazards.

Contaminants from marine transportation activities enter the sea intentionally as a result of routine operational discharges, and unintentionally as a result of accidental spills. Vessel sizes and designs are as varied as their functions. They range from small recreational craft used primarily in coastal waters to defense-related naval vessels and ships of the merchant marine fleet up to several hundred thousand tons in size. With respect to ships that maintain sizeable crews, the pollutants are the large amounts of domestic waste products such as sewage, food waste, and trash from the human activities on board. For recreational vessels, sewage disposal from marine sanitation devices in highly populated, confined harbors and anchorages is the primary pollution concern. Other problems are related to the movement of crude oil and concern offshore unloading terminals (deepwater ports) and identification of systems most reliable for transfer of oil from OCS production areas to shoreside facilities.

Perhaps the most publicized source of pollution is operational discharge of oil by tankers in the merchant marine fleet. Because tankers cannot safely navigate ocean waters with empty tanks, they take on seawater as ballast after the cargo is discharged. When a ship gets close to its loading destination, the ballast water is discharged to make room for the oil cargo. Thus the ballast seawater, contaminated with oil from the previous cargo or from tank washing, is sometimes intentionally discharged into the ocean. In 1979 alone, an estimated 2.5 million gallons of petroleum hydrocarbons were discharged from ships operating within the Gulf, under normal operating conditions (USDC, NOAA, 1985). Regulation, coupled with the increased value of oil, has led to development of new and better techniques such as segregated ballast, crude-oil washing systems, and oil/water separation systems for minimizing contamination of ballast water. Nevertheless, enforcement of regulations and standards is still a problem.

Oil spills are one of the most highly visible forms of ocean pollution. Recently, it has been recognized that spills of hazardous materials may, in many cases, pose a more serious threat to marine ecosystems than oil spills. Substantial amounts of oil and hazardous materials enter the marine environment as a result of accidental spills. Although the focus in the past has been on the cleanup and mitigation of spilled oil, national concern has been shifting toward hazardous materials as the cause for most immediate concern. Much has been learned in the past 10 years about how to respond to oil spills; far less is known for spills of hazardous material. Unlike oil, whose properties are fairly uniform, hazardous materials have a wide variety of physical and chemical forms, complicating and making much more difficult the response necessary for their cleanup and disposal. Methods for the cleanup and mitigation of hazardous materials are not well established. No hazardous chemicals are used in the production of sulphur.

Between 1946 and 1970 the Atomic Energy Commission (AEC) licensed the dumping of more than 86,000 containers of low-level radioactive wastes at 28 recorded dumpsites in the Atlantic and Pacific Oceans and the Gulf of Mexico. Of these, only two dumps were made in the Gulf of Mexico (U.S. Environmental Protection Agency, 1980). Ocean dumping was discontinued in June 1970 following a policy recommendation by the President's Council on Environmental Quality (CEQ) in its 1970 report to the President. The United States has never disposed of its high-level wastes in the oceans, and in 1972 two major legislative initiatives were enacted prohibiting future disposal of high-level wastes into coastal waters and rivers. The Ocean Dumping Act, in addition to regulating ocean disposal of low-level waste, prohibits the dumping of high-level waste and radiological warfare agents in ocean waters. Soon after the Ocean Dumping Act was enacted, the Clean Water Act was amended to extend the prohibition to all navigable waters. Although not immediately contemplated, subseabed emplacement of high-level radioactive wastes is a future option.

A concentrated brine solution needing disposal results from the development and operation of salt dome storage cavities associated with the Stragetic Petroleum Reserve (SPR) Program, which is mandated by the Energy Policy and Conservation Act of 1975 (42 U.S.C. 6201 et seq.). The brines are normally discharged into the Gulf of Mexico through diffusers to promote rapid dilution to background salt concentrations. However, the brines are denser than seawater and tend to flow along the seafloor, affecting bottom-dwelling organisms until sufficient dilution has been achieved. In addition, hydrocarbons and other harmful constituents may be dissolved in or entrained with the brine discharge. Brine discharges are regulated by USEPA under NPDES.

Conclusion

The level of cumulative impact on offshore water quality is estimated to be high.

d. Impacts on Air Quality

The major impact producing factors on air quality from OCS-related activity are due to combustion, evaporation, or venting of hydrocarbons. In the offshore environment, potential impact producing activity includes catastrophic events and operational emissions.

In the onshore environment, potential impact producing activity includes the operation of sulphur storage, processing plants, and vessel loading. These are discussed further in Section IV.A.3.

Definitions of expected levels of impact related to air quality are defined in Table S-3. Significant concentrations relative to these definitions are detailed in Tables IV-8 and IV-9.

Table IV-8

Ambient Air Pollutant Concentrations

Pollutant	(mg/m^3)	Averaging Time
SO_2	1/5/25	Annual/24 hr/3 hr
TSP	1/5	Annual/24 hr
NO_2	1	Annual
CO	500/2,000	8 hr/1 hr
*VOC	—	1 hr

Note: To achieve a level of significance, these concentrations must be exceeded by a facility.

*If VOC emission is greater than 100 tons per year for a facility, it may be considered to have significance.

(Refer to 30 CFR 250.57)

Impact Analysis

The ambient air quality in the CPA is generally considered better than the national standards with violations of the NAAQS occurring in some coastal areas; these areas where violations occur are designated as nonattainment areas. Additionally, there is one PSD Class I area in the coastal region (Breton Wilderness Area) whereby a small amount of degradation to ambient air quality is considered significant. All nonattainment and PSD Class I areas in the CPA are identified below:

St. John the Baptist, Louisiana
  Nonattainment - Primary - O_x
Orleans, Louisiana
  Nonattainment - Primary - O_x
Jefferson, Louisiana
  Nonattainment - Primary - O_x
St. Bernard, Louisiana
  Nonattainment - Primary - O_x
St Charles, Louisiana
  Nonattainment - Primary - O_x
Lafourche, Louisiana
  Nonattainment - Primary - O_x
St. Mary, Louisiana
  Nonattainment - Primary - O_x
Mobile, Alabama
  Nonattainment - Primary - O_x
St. Bernard/Plaquemines, Louisiana
  PSD Class I - Breton Wilderness Area

Catastrophic events are not possible to predict in time and location. Effects from these nonroutine activities are highly dependent on the distance offshore, H_2S content, and proximity to a nonattainment or PSD area. Higher impacts will occur if these events affect nonattainment or PSD Class I areas. (See Section IV.A.3. for a further discussion.) The nearest tracts to shore are three miles, and those tracts are some 25 miles from the nearest town. The nearest offering to a town where a catastrophic event releasing H_2S could affect the population is some 18 miles. At these distances, any H_2S would be dispersed to a safe level. Such an event, however, could affect personnel on nearby oil and gas platforms and drilling rigs.

Table IV-10 displays air emissions estimates under the proposed action using M Scenario assumptions. An average annual figure is given for each activity and pollutant along with a total average for the proposed action. Computing the average requires estimating emissions for operational activities. This allows for an accounting of emissions for both drilling and production. It is recognized that all activities do not occur at the same time. Drilling work is predominant in the early phases of exploration and development while platform production expands gradually throughout the operating period. As production activity increases, drilling activity decreases.

Table IV-9

Air Quality
Maximum Allowable Increase
(micrograms per cubic meter)

Class I

Pollutant	
Particulate matter:	
Annual geometric mean	5
24-hr maximum	10
Sulfur dioxide:	
Annual arithmetic mean	2
24-hr maximum	5
3-hr maximum	25

Class II

Particulate matter:	
Annual geometric mean	19
24-hr maximum	37
Sulfur dioxide:	
Annual arithmetic mean	20
24-hr maximum	91
3-hr maximum	512

Class III

Particulate matter:	
Annual geometric mean	37
24-hr maximum	75
Sulfur dioxide:	
Annual arithmetic mean	40
24-hr maximum	182
3-hr maximum	700

(Refer to 40 CFR 52.24 and 30 CFR 250.57)

Table IV-10

Average Annual Air Emissions Under M Scenario Assumptions (tons/year)

	NO_X	CO	SOx	VOC	TSP	Number Wells/Platforms
Proposed Action						
Drilling Operations	155	23	10	5	NA	1,078
Platform Operations	41	8	1	18	0.3	7
Total	196	31	11	23	0.3	

Note: Drilling operations include exploration, delineation, development, sidetrack, and bleedwater wells and salt wells. The platforms are assumed major platforms capable of producing emissions. The averages are based on an 18-year activity period.

The impact of OCS emissions resulting from the proposed action cannot be measured with available information. The spatial distribution of rigs and platforms, the temporal distribution over time, and the specific equipment producing emissions are unknown. The number of wells drilled and platforms installed are estimated in Table IV-1. Emission controls or offsets are not expected to be necessary for offshore facilities.

Coastal parishes adjacent to the potential annual offshore development with a status as nonattainment or having PSD Class I areas are: St. John the Baptist, Orleans, Jefferson, St. Bernard, St. Charles, Lafourche, St. Mary, and Plaquemines Parishes, Louisiana. The expected levels of activities adjacent to these parishes are not large. These activities are not expected to occur simultaneously and are not expected to cause impacts above the level defined as low. Low impacts can be based soley on the amount of activity expected to occur, i.e., nonattainment areas are unlikely to be degraded further.

Additionally, no significant deterioration of onshore air quality is expected from routine offshore operational emissions due to the regulatory control provided in 30 CFR 250.57. These regulations limit emissions from OCS facilities relative to significance levels outlined in Tables IV-39 and IV-40 of the Final Regional EIS. The regulations require that individual analysis of emissions produced by proposed structures in the Gulf of Mexico be performed. These regulations insure that impacts do not rise above an upper level (moderate) and will be considered nonsignificant. Impacts are controlled by regulations in this case such that public health and welfare are protected at an acceptable level. Impacts from uncontrolled (nonroutine) events could be higher.

Conclusion

Low impacts to air quality are expected in St. Bernard, Plaquemines, St. Mary, Lafourche, St. Charles, Jefferson, Orleans, and St. John the Baptist Parishes in Louisiana and Mobile County in Alabama. Very low impacts are expected throughout the remainder of the coastal area of the Central Gulf and in Escambia County in the Eastern Gulf.

Cumulative Impacts

This cumulative analysis considers the effects of impact producing factors related to the proposed action plus those related to prior and future oil and gas OCS sales, State oil and gas activity, power generation, industrial activity, waste incineration, petrochemical processing and storage, vehicular and waterborne transportation, and other activities that may occur and adversely affect air quality in the same general area that may be affected by OCS oil and gas activity located in the CPA. Impact producing factors considered in the analysis are the routine emissions (point source and mobile) related to the above activities.

Point source emissions from onshore activities, such as non-OCS oil and gas processing, power generation facilities, industrial processing or manufacturing facilities, waste incineration facilities, petrochemical storage facilities, and mobile emissions sources (automobiles, waterborne transportation, etc.), are expected to increase at rates in proportion to the growth of population. Energy conservation, improved automobile emission controls alternative (non-fossil fuels) energy generation facilities, and new waste disposal technology are factors that will determine the rate of change in air quality. Due to population in-migration throughout the Gulf region, the ambient air quality will probably degrade, over time, due to the overall effects of these activities and OCS-related activities. Ambient air quality is not expected to degrade beyond attainment standards where it is currently better than those standards or where PSD areas are located. The effects of all emissions on areas presently classified as nonattainment will be reduced over time so that attainment standards will be met. Controls and offsets may be applied to emissions sources to meet these standards.

The estimate aggregate OCS offshore emissions under the cumulative scenario are presented in Table IV-11. Estimates are included for emissions of No_X, CO, SOx, VOC, and TSP which would be generated by exploratory and development well drilling and routine platform operations. Existing platform distances to shore may range from 3 miles to over 150 miles for oil and gas activities. Sulphur producing platforms, based on nominated tracts, may range from 3 to 95 miles offshore.

Emissions for OCS installations are calculated at the time of permitting production facilities. Such factors as the distance to shore, climatological conditions, and emissions producing equipment on each platform is analyzed as to its contribution to degradation of air quality. Since records have been kept (June 1980), this air quality permitting analysis has identified a negligible contribution in the CPA.

No new sulphur storage or processing plants are estimated to result from this proposed sulphur/salt sale. It is assumed that new source performance standards and best available control technology will meet air quality standards imposed by existing regulations. It can be assumed that impacts will be their highest (relatively) in the following parishes/counties which are classified as nonattainment or PSD Class I areas: St. John the Baptist, Orleans, Jefferson, St. Bernard, St. Charles, Lafourche, St. Mary, and Plaquemines Parishes in Louisiana, and Mobile County in Alabama.

It must be noted that these areas identified are nonattainment areas for a specific pollutant (O_X, and TSP). Gas processing produces specific SO_X emissions only. Therefore, these activities will not be a significant contribution to the identified parishes/counties, except that these activities may use an increment of the allowable SOx limit.

Conclusion

The level of cumulative impact to air quality is estimated to be moderate.

Table IV-11

Cumulative OCS Offshore Average
Annual Air Emission Estimates

	Pollutant/Emissions (1,000 tons)				
	NO_X	CO	SOx	VOC	TSP
Sulphur Mining Operations[1]	0.196	0.031	0.011	0.023	0.0003
Oil/Gas Operations to be Developed[2]	2.200	0.350	0.113	0.300	0.0026
Existing Oil/Gas Platform Operations[2]	5.600	1.050	0.087	2.370	0.0270
Total	7.996	1.431	0.211	2.693	0.0299

[1] Based on an 18-year operating period.
[2] Based on a 23-year operating period.

e. Impacts on Endangered and Threatened Species

The definitions of impact levels for endangered and threatened species are defined in Table S-3. An endangered species consultation pertaining to this proposed action was initiated with FWS and NMFS in January 1987. No biological opinions have been issued to date.

(1) Brown Pelicans

Impact Analysis

The impact producing factors which could affect brown pelicans in the CPA include OCS-related sulphur and oil spills; disturbance from pipeline placement and onshore coastal facility construction near nesting and feeding areas; displacement of birds from feeding and nesting areas due to aircraft and vessel traffic; and entanglement or ingestion of debris and trash.

If a sulphur spill should occur, it is unlikely it would contact a pelican nesting area. If the sulphur spill occurred in a pelican feeding area, it may have an impact on the food organisms in the area of the spill, but no major impact on pelicans.

If an oil spill should occur and contact brown pelican nesting and/or feeding areas, the pelicans could suffer mortality or reduced reproduction capacity. Pelicans are vulnerable to oil spills because as they plunge-dive during feeding or rest on the water, an oil slick could contaminate their feathers. This could result in the ingestion of oil as the feathers are preened or oil could be ingested during feeding. Should the food source itself be contaminated with oil, additional oil may be ingested. Ingestion of oil has been shown to cause reproductive losses in many bird species (Section IV.A.3.k.(2)(b)). Oil coming in contact with nesting areas could also result in oiling of feathers and contamination of eggs or chicks, resulting in mortality.

There are four major feeding and nesting sites inhabited by brown pelicans in the Central Gulf coastal area. One site is located in the vicinity of Queen Bess Island in Lafourche Parish, Louisiana. A site is located in the vicinity of North Island in St. Bernard Parish, Louisiana. A small site is located near the mouth of the Pearl River in Hancock County, Mississippi. Another small site is located on Gaillard Island (near Theodore) in Mobile County, Alabama.

The pelican feeding and nesting habitat in Lafourche and St. Bernard Parishes are more likely to be contacted by sulphur spills or secondary oil spills than those in Hancock and Mobile Counties because they are nearer the proposed sulphur leasing areas. There is a very low chance that any of the pelican habitat areas will be contacted by a sulphur spill or secondary oil spill as a result of this proposed action (Section IV.A.1.). Due to the low chance of sulphur spill or secondary oil spill contacts, the level of impact to brown pelicans from sulphur spills or oil spills should be very low.

Noise disturbance from aircraft and vessel traffic during nesting season can cause pelicans to leave or abandon their nests, which could result in the loss of eggs and mortality of chicks and/or juvenile birds. About 1,512 related barge and vessel trips/mine are estimated to occur in the CPA during the peak year of the proposed action; this is less than 1% of the total barge and vessel traffic in the Central Gulf. Only the pelican nesting site in Lafourche Parish is likely to experience moderate numbers of helicopter and aircraft (1,460) and vessel traffic during peak year activity. This traffic usually does not approach close enough to nest sites to disturb pelicans because of minimum altitude restrictions and shallow water depth. The expected impact on brown pelicans from noise disturbance as a result of the proposed action should be very low.

The placement of pipelines and the construction of onshore facilities near pelican feeding and nesting sites not only removes habitat available for nesting sites, but also noise associated with human activity makes additional areas unavailable for nesting. Up to 2 pipeline landfalls, and about 20 miles of onshore pipelines could be constructed in the CPA. This coastal construction is not likely to impact brown pelicans unless it is located near nesting/feeding habitat in Lafourche/St. Bernard Parishes as a result of this proposed action (Section IV.A.1.). No direct or indirect impacts are expected to occur to pelicans from bleedwater/salt well platform installation, brine pipeline emplacement, or bleedwater effluents. As a result of this proposed action, there is a very low potential of injury or death of brown pelicans from entanglement and/or ingestion of debris and trash. Plastic line, netting, and 6-pack rings can entangle the pelicans' feet, head, and/or wings causing entrapment and/or strangulation. Plastic bags, sheeting, and styrofoam can be ingested, causing internal blockage resulting in starvation (Centaur Associates, Inc. and Center for Environmental Education, 1986).

Conclusion

A very low level of impact on brown pelicans and their feeding and nesting habitat is expected to occur in the Central Gulf as a result of the proposed action.

Cumulative Impacts

This cumulative analysis considers the effects of impact producing factors related to the proposed action plus those related to prior, proposed, and future OCS oil/gas/sulphur activities, State offshore oil/gas/sulphur activities, air and waterborne transportation, dredging, commercial and recreational fishing, coastal land development activities, and coastal storms and hurricanes. Specific impact producing factors considered in the analysis include sulphur or secondary oil spillage, land alteration and development, marine debris and trash, noise and physical presence, water and food contamination, and the destructive aspects of natural events.

Cumulatively, there is a 65% chance of one or more oil spills (1,000 bbls or greater) contacting brown pelican habitats from prior, proposed, and future OCS oil/gas activities and crude oil tanker imports (Section IV.A.2.c.). The brown pelican habitat in Lafourche Parish, Louisiana, has a 71% chance of being contacted by one or more (1.2) spills; habitats located in St. Bernard Parish (Louisiana), Hancock County (Mississippi), and Mobile County (Alabama) have up to a 36%, 31%, and 5% chance, respectively, of being contacted (USDI, MMS, 1987b). State offshore oil/gas activity and the high levels of oil and organic chemical contamination in river water located in the same general areas as the brown pelican habitats represent additional risk of adverse affects. The cumulative impact of oil spills and probable water and food contamination could result in a moderate level of impact on brown pelicans in the CCA.

The cumulative estimate for OCS oil/gas/sulphur-related helicopter and vessel traffic for the 1987-1992 period is approximately 116,980 helicopter trips and 25,536 vessel trips (USDI, MMS, 1987b).

Disturbance from aircraft and vessel traffic in the vicinity of pelican nesting areas in the CPA is not likely to increase above current levels as a result of offshore oil/gas/sulphur activities. About 97% of the boat and ship traffic in this area is non-OCS-related traffic such as: commercial tanker/cargo vessels; commercial and recreational fishermen; intracoastal tug and barge traffic; and maintenance dredging operations.

Estimates of cumulative offshore-related oil/gas onshore development and support facilities (Section IV.A.2.c.) are: 7 service bases, 4 pipe storage and coating yards, 13 pipeline landfalls, 180 miles of onshore pipeline, 5 platform fabrication yards, and 5 gas processing plants. Cumulative Federal OCS sulphur-related activity is estimated to result in 2 pipeline landfalls and 20 miles of onshore pipeline. If all these facilities are constructed, it could require an estimated total of 4,875 acres for oil/gas facilities and about 20-30 acres for sulphur facilities in the CPA coastal region. These facilities are not likely to be located so as to cause adverse affects to brown pelican habitats.

Impacts related to non-OCS activities would include the loss of habitat to commercial, military, recreational, and residential development in the coastal zone; dredging and draining of wetlands and coastal feeding/nesting areas; high levels of oil and organic chemical contamination of coastal waters and food sources; agricultural runoff and industrial wastes; the disturbance from aircraft and vessel traffic in nesting and feeding areas; entanglement in commercial and recreational fishing gear; entanglement or ingestion of marine debris and trash (particularly plastic materials); collision with power lines and towers (Avery et al., 1980); and coastal storms and hurricanes cause flooding and destruction of nesting areas. These impact producing factors, in aggregate, are judged to result in a substantial (but not readily quantifiable) amount of adverse affects on brown pelicans by destroying, altering, and disturbing their habitats, and by causing their injury and death.

There is a low potential for impacts to brown pelicans from entanglement or ingestion of debris and trash from offshore oil/gas/sulphur-related activities.

Conclusion

The cumulative impact on brown pelicans is estimated to be moderate.

(2) Sea Turtles

Impact Analysis

The impact producing factors which could potentially affect sea turtles in the CPA include offshore-related sulphur spills, secondary oil spills, collision with sulphur barges or service vessels, use of explosives for the removal of offshore platform legs/pilings, pipeline construction across nesting beaches, and entanglement or ingestion of debris and trash.

Occasional loggerhead nesting has occurred on the Chandeleur Islands off Louisiana and on Horn and Ship Islands off Mississippi. No green, leatherback, ridley, or hawksbill turtle nesting has been reported in the CPA. Loggerhead and Kemp's ridley turtles forage off the Louisiana coast (Fuller and Tappan, 1986). Data from 1986 marine turtle strandings indicate 29 loggerhead, 89 ridley, 1 green, 3 leatherback, and 1 hawksbill turtle for Louisiana; 7 loggerhead and 1 each ridley, green, leatherback, and hawksbill turtle for Mississippi; and none for Alabama (USDC, NMFS, 1987).

The probability of an sulphur/spill occurring and contacting sea turtle nesting habitat on Chandeleur, Horn, or Ship Islands as a result of the proposed action is very low. Very little sea turtle nesting occurs in the Central Gulf area, and considering the low chance of a sulphur spill or secondary oil spill occurring and contacting turtle nesting habitat, the level of impact on turtle nesting habitat should be very low. It is unlikely a sulphur spill will have a significant impact on sea turtles. However, a sulphur spill could impact food organisms in a localized area surrounding the spill site.

Oil spills contacting a turtle nesting beach during egg incubation or hatching periods (June-August) could cause significant turtle mortality (Fritts and McGhee, 1981). Offshore oil spills could have a serious impact on sea turtles. Floating oil could result in mortality of turtles by contacting the turtles when they surface to breathe and indirectly by affecting food sources (Carr, 1986). There is a very low chance of a large oil spill occurring in the Central Gulf as a result of this proposed action. An offshore oil spill could contact sea turtles while they are basking, surfacing to breathe, or feeding and cause deleterious effects. Because of the very low number of oil spills expected and the low numbers of sea turtles which occur in the CPA, the probability of sea turtles contacting an oil spill offshore Louisiana as a result of the proposed action is low.

Barge and vessel traffic related to the proposed action poses a minor collision threat which could cause serious injury or mortality to sea turtles. Information on the number of barge/vessel/turtle collisions in this area is not available; however, no adverse effects of vessel traffic on sea turtles has been reported or documented in the CPA. Considering the estimated level of offshore-related vessel traffic (about 1,512 barge and vessel trips during the peak year, which is less than 1% of the annual vessel traffic) that would pass through turtle habitats in relation to the estimated numbers of sea turtles in these areas, the level of expected impact is estimated to be very low.

As a result of the proposed action, about 18 platforms may be installed in 3 to 4 separate sites in the CPA (Section IV.A.1.a.). In about 10-25 years these platforms may be raised, replaced, or removed. If the current method of platform removal (use of explosives) continues to be utilized, there is a potential for sea turtles within 1,000 ft of the detonation (depending on the type, amount, and placement of the explosives) to be injured or killed. When the platforms resulting from this proposed action are due for removal, it is expected that platform removal technology will be developed which prevents injury to sea turtles. No direct or indirect impacts are expected to occur to sea turtles from bleedwater/salt well platform installation, brine pipeline emplacement, or bleedwater effluents. (For an overall discussion of platform removals, see USDI, MMS, 1987a). The level of impact to sea turtles resulting from this activity is estimated to be very low.

Up to 2 pipeline landfalls and about 20 miles of onshore pipelines could be constructed in the CPA. As very little turtle nesting occurs in the CPA, this potential coastal construction is not likely to impact sea turtles.

As a result of the proposed action, there is a very low potential of injury or death of sea turtles from entanglement and/or ingestion of debris and trash. Sea turtles can become entangled in plastic line, netting, and 6-pack rings which may result in strangulation or drowning. Ingestion of tar, plastic bags or sheeting, and/or styrofoam can cause internal blockage resulting in starvation (Centaur Associates, Inc. and Center for Environmental Education, 1986).

Conclusion

A very low level of impact on sea turtles is estimated to occur in the Central Gulf area as a result of the proposed action.

Cumulative Impacts

This cumulative analysis considers the effects of impact producing factors related to prior, proposed, and future OCS oil/gas/sulphur activities, State offshore oil/gas/sulphur activity, crude oil imports by tanker, commercial fishing, military, recreational and marine transportation, and other activities that may occur and adversely affect sea turtles. Specific types of impact producing factors considered in the analysis include oil/sulphur spills, vessel traffic, pipeline landfall construction, platform removal, commercial fishing techniques (trawling, longline gear, crab pot lines), marine debris and trash, operational discharges from tank ships, and beach cleaning and development.

The cumulative number of oil spill (1,000 bbls or greater) occurrences in the Gulf is 56.2 over a 35-year period. The highest probability of a large oil spill contact is in Plaquemines Parish, Louisiana, where about 2.4 oil spill contacts could occur (USDI, MMS, 1987b). The area between Marsh Island and the Mississippi Delta (St. Mary, Terrebonne, Lafourche, Jefferson, and Plaquemines Parishes) is a major feeding area for loggerhead and ridley turtles. Oil spills in this area could result in some sea turtle injury or mortality. The expected cumulative impact of oil spill contacts on sea turtles in this area is estimated to be moderate.

Cumulative Federal OCS sulphur-related activity is estimated to result in 2 pipeline landfalls, 20 miles of onshore pipeline, and up to 18 platforms.

In the CPA, there are about 800 offshore oil/gas platforms in State waters and 2,800 platforms in Federal waters. Over the next 15-25 years, many of these platforms may be removed. The annual rate of platform removal in Federal waters is about 55-65; this rate will increase as more platforms become obsolete/unused (National Research Council, 1985). The usual method for platform removal is to sever the supporting legs/pilings about 15 ft below the seafloor using explosive charges. If explosives continue to be used for platform removals, there is a potential for sea turtles within 1000 ft of the detonation (depending on the type, amount, and placement of the explosives) to be injured or killed. In the future, it is expected that improved platform removal technology will provide an environmentally safe method which prevents injury to sea turtles. The level of impact to sea turtles resulting from this activity is estimated to be moderate.

Impacts not related to OCS oil/gas/sulphur activities include the loss of sea turtle nesting beaches to commercial, recreational, and residential development along Louisiana beaches; very high mortality caused by commercial trawling, longline fishing gear, and entanglement in crab pot lines; entanglement/ingestion of marine debris and trash (particularly plastic materials); natural and man-induced predation of turtles and eggs on nesting beaches throughout the Gulf of Mexico and Caribbean Sea regions; oil/tar balls from natural seeps, bilge cleaning, and tanker spills; compaction, subsidence, and flooding of nesting beaches; dumping of contaminated wastes into the sea; coastal dredging; and collision with commercial, military, and recreational vessels. In 1986, about 600 turtle strandings were reported for the Gulf of Mexico (USDC, NMFS, 1987). These impact producing factors, in aggregate, are judged to result in a substantial (but not readily quantifiable) amount of adverse effects on sea turtles by the destruction, alteration, and/or disturbances of feeding and nesting areas, and injury and mortality of numerous individuals.

Conclusion

The cumulative level of impact on sea turtles in the CPA is estimated to be very high.

f. Impacts on Marine Mammals (Whales)

Impact Analysis

The impact producing agents which could affect marine mammals include offshore sulphur spills, oil spills, collision with barges/supply vessels, use of explosives for the removal of offshore platform legs/pilings, disturbance from sulphur activities, and entanglement or ingestion of debris and trash.

Very little information is available on the effect of a sulphur spill on marine mammals. It is believed that if liquid sulphur is spilled into the marine environment, it would solidify and sink to the bottom with very little impact to marine mammals except for the remote possibility of secondary effects of a slight temperature elevation and the unlikely possibility of some mechanical damage during recovery operations. Unless a marine mammal would be in the vicinity of a sulphur spill, it is unlikely that a sulphur spill would have a significant impact on marine mammals.

Based on laboratory research (Geraci and St. Aubin, 1982; Goodale et al., 1981; and Gruber, 1981), the most likely effects of oil on marine mammals are: (a) a mild and deleterious, but reversible, effect on the skin; (b) possible eye irritation, which would be reversible unless exposure was prolonged; (c) possible short-term baleen fouling with possible feeding reduction for 1 or 2 days; (d) possible blowhole fouling and death due to respiratory stress for very young animals in heavy oil; and (e) temporary food reduction or contamination, and oil ingestion by whales. Potential, but unlikely, effects include: (a) possible mortality due to respiratory stress; (b) possible mortality to young or already stressed animals immediately after a spill, due to ingestion of oil or inhalation of vapors; and (c) possible mortality due to stress of individuals that are already stressed. Mortality has not been verified for any marine mammals due to an oil spill. Therefore, it could be assumed that, if deaths occurred, the percentage would be very low.

Although the endangered sperm whale is uncommon in the Gulf of Mexico region (Mead, 1975), it is probably the most numerous endangered whale species in this region (Table III-3 of Draft EIS 113/115/116). Very few whales have been sighted in the CPA (Fritts et al., 1983). The major whale habitat in the Gulf is in deepwater, off the continental shelf, while most of the current OCS sulphur activities occur on the shelf.

Deepwater marine mammal habitat is unlikely to be contacted by a sulphur spill or secondary oil spill resulting from this proposed action, and the chance of a marine mammal contacting a sulphur spill or secondary oil spill resulting from this proposed action is very low.

As a result of the proposed action, barge/supply vessel traffic is estimated to be about 1,512 trips (per mine for the peak year) which is less than 1% of the total annual barge/supply vessel traffic in the Central Gulf (Section IV.A.1.). The level of OCS-related vessel collisions with marine mammals in the Central Gulf is unknown; no injuries or mortalities have been reported. The level of impact to marine mammals resulting from OCS-related barge/supply vessel collisions should be very low.

As a result of the proposed action, about 18 platforms may be installed in 3 to 4 separate sites in the CPA. In about 10-25 years these platforms may be relocated or removed. If the current method of platform removal (use of explosives) continues to be utilized, there is a potential for marine mammals located within 1,000 ft of the detonation (depending on the type, amount, and placement of the explosives) to be injured or killed. When the platforms resulting from this proposed action are due for removal, it is expected that platform removal technology will be in use which prevents injury to marine mammals. No direct or indirect impacts to marine mammals are expected to occur from bleedwater/salt well platform installation, brine pipeline emplacement, or bleedwater effluents. For an overall discussion of platform removals, see USDI, MMS, 1987a. The level of impact to the marine mammal population in the CPA resulting from this activity should be very low.

About 60 exploration/delineation, 324 development, and 576 sidetrack wells may be drilled (Section IV.A.1.a.), and some site specific seismic exploration may be required. Underwater sounds from well drilling and seismic activities (Section IV.A.3.i.) apparently do not pose a significant impact to marine mammals (Malme et al., 1984; Gales, 1982; and USDI, MMS, 1983b). No adverse impacts resulting from these activities have been reported or documented in the Gulf of Mexico region. The disturbance is usually short-term and fairly localized near the source, and it is unlikely to cause a major impact on marine mammals in the Central Gulf.

Marine mammals can become entangled in plastic line, netting, and cargo straps which may result in strangulation or drowning. Ingestion of plastic bags, sheeting, and/or styrofoam can cause internal blockage resulting in starvation (Centaur Associates, Inc. and Center for Environmental Education, 1986). As a result of this proposed action, there is a very low potential of injury or death of marine mammals from entanglement and/or ingestion of debris and trash.

Conclusion

This proposed action is expected to have a very low level of impact on marine mammals.

Cumulative Impacts

This cumulative analysis considers the effects of impact producing factors related to prior, proposed, and future OCS oil/gas/sulphur activities, State offshore oil/gas/sulphur activity, crude oil imports by tankers, commercial fishing, platform removal, and other activities that may occur and adversely affect marine mammals. Specific impact producing factors considered in the analysis include oil spills, sulphur spills, barge and supply vessel traffic and noise, seismic exploration, commercial and military sonar, fishing gear, underwater cables, marine debris and trash,and ocean disposal of toxic materials.

Impacts to marine mammals could result from the occurrence of an estimated 56.2 oil spills (1,000 bbls or greater) in the Gulf (USDI, MMS, 1987b). These oil spills are expected to have a low level of cumulative impact on marine mammals. Oil/gas exploration and development on the continental slope and deepwater areas could affect sperm whales which feed on squid in deepwater areas.

The barge and supply vessel traffic estimated for the proposed action is less than 1% of the annual commercial, military, and recreational vessel traffic in the offshore areas inhabited by marine mammals. About 268,340 vessel trips of all types were recorded for the CPA in 1982, primarily into major port areas.

In the CPA, there are about 800 offshore oil/gas platforms in State waters and 2,800 platforms in Federal waters. Over the next 15-25 years, many of these platforms will be removed. The annual rate of platform removal in Federal waters is about 55-65; this rate will increase as more platforms become obsolete/unused (National Research Council, 1985). The usual method for platform removal is to sever the supporting legs/pilings about 15 ft below the seafloor using explosive charges. If explosives continue to be used for platform removals there is a potential for marine mammals located within 1,000 ft of the detonation (depending on the type, amount, and placement of the explosives) to be injured or killed. In the future, it is expected that improved platform removal technology will provide an environmentally safe method which prevents injury to marine mammals. The estimated cumulative level of impact from this activity could be high.

Seismic exploration will occur on an estimated 2,554 lease blocks, and sound will be generated from an estimated 2,800 offshore platforms and 25,536 supply/crew boat and 116,980 aircraft trips (USDI, MMS, 1987b). Additional sound is produced by commercial, military, and recreational vessels; aircraft; and commercial and military sonar. The majority of these disturbances and noises are usually localized around the source and are fairly short-term. Other cumulative impacts from disturbances and noises in other feeding/migratory areas of the Caribbean Sea and Atlantic Ocean are uncertain. The cumulative impact from these disturbances and noises should be low.

Other impacts on marine mammals which are not related to OCS sulphur activities include entrapment, injury, and mortality in fishing gear and underwater cables. Several whale species were hunted to near extinction during the 1800's, and commercial and subsistence hunting of some whale species still continues. About 15-20 bottlenose dolphins are taken each year from the Gulf of Mexico for public display. Ocean disposal of chemicals, radioactive wastes, munitions, etc., could contaminate marine mammal food sources. Marine debris and trash, lost and cast off nets, cargo straps, and plastic sheeting and bags are responsible for the starvation and strangulation deaths of marine mammals (Centaur Associates, Inc. and Center for Environmental Education, 1986).

Conclusion

The cumulative level of impacts on marine mammals in the CPA are estimated to be high.

g. Impacts on Coastal and Marine Birds

The definitions of impact levels for coastal and marine birds (non-endangered) are defined in Table S-3.

Impact Analysis

The impact producing agents which could potentially affect coastal and marine birds as a result of the proposed action include: OCS-related sulphur spills; secondary oil spills; disturbance from onshore facility construction near coastal nesting areas; displacement of birds from feeding and nesting areas due to aircraft, barge, and vessel traffic; and entanglement and/or ingestion of debris and trash.

A liquid sulphur spill would cool and solidify without much environmental impact; some noxious fumes and steam may occur in the immediate vicinity of a spill and some food organisms may be smothered but no significant impact to coastal and marine birds are expected to occur. Many of the coastal and marine bird species in the CPA, which are susceptible to oil spills, are migratory and could be exposed to spills during their over-wintering period (October-March). Oiling of birds causes death from hypothermia, shock, or drowning; oil ingestion significantly reduces reproduction in some birds; and oil contamination of eggs by oil-fouled adult birds reduces hatchability. Indirect effects of oil pollution on birds include contamination, displacement, and reduction of food sources. Long-term contamination of food sources and habitats may cause chronic toxicity to birds through the accumulation of hydrocarbon residues and may affect their behavior, physiology, and reproduction.

Numerous species of coastal and marine birds feed and nest all along the Central Gulf coastline (Clapp et al., 1982 and Portnoy, 1977). The majority of the coastal and marine bird nesting habitat occurs inshore and is unlikely to be impacted by coastal oil spills. The majority of the coastal and marine bird feeding habitat is nearshore (or inshore) and could be contacted by oil spills.

Disturbance of coastal and marine bird nesting and feeding habitat from onshore construction and associated noise from aircraft, barge, and vessel traffic could result in a reduction or desertion of birds that use the habitat for feeding and nesting. Dredging and the construction of pipelines and roads could change hydrology that may result in complete conversion of a marsh ecosystem.

It is estimated that during the peak year of this proposed action about 1,512 OCS sulphur-related barge and vessel trips and 1,460 helicopter trips will occur per mine. This is less than 1% of the annual vessel traffic in the CPA. The majority of this vessel traffic occurs in/out of existing port areas and probably will not have a significant impact on coastal and marine birds. Up to 2 pipeline landfalls and about 20 miles of onshore pipelines could be constructed in the CPA as a result of this proposed action.

Coastal and marine birds can become entangled in plastic line, netting, 6-pack yolks, etc., which may result in injury, strangulation, or drowning. Ingestion of plastic and/or styrofoam materials may cause internal blockage resulting in starvation (Centaur Associates, Inc. and Center for Environmental Education, 1986). As a result of this proposed action, there is a very low potential of injury or death of coastal and marine birds from entanglement and/or ingestion of debris and trash.

Conclusion

In the Central Gulf, the proposed action is expected to have a very low level of impact on coastal and marine birds.

Cumulative Impacts

This cumulative analysis considers the effects of impact producing factors related to prior, proposed, and future OCS oil/gas/sulphur activities, State offshore oil/gas/sulphur activity, crude oil imports by tanker, and other commercial, military, and recreational offshore and coastal activities that may occur and adversely affect coastal and marine birds. Specific types of impact producing factors considered in the analysis include oil spills; sulphur spills; aircraft, barge, and vessel traffic; coastal construction; dredging; fishing gear; marine debris and trash; and water contamination.

In the Gulf the estimated cumulative number of oil spills resulting from prior, proposed, and future OCS leasing and tankering of imported oil is about 56.2 spills. Plaquemines Parish, Louisiana, is the area with the highest probability of oil spill contact due to the extensive oil development in the Mississippi Delta area and the tankering of imported crude oil and petroleum products on the Mississippi River. Coastal and marine birds that migrate through more than one OCS planning area may be exposed to oil spills in other areas. The cumulative impact on coastal and marine birds from oil spills in the CPA is estimated to be moderate.

Disturbance from aircraft, barge, and vessel traffic in the vicinity of bird feeding and nesting habitat in the CPA is not likely to increase above current levels as a result of oil/gas/sulphur activities. About 97% of the aircraft, barge, and vessel traffic in the CPA is not related to OCS oil/gas/sulphur activities.

Cumulative impacts will moderately increase as a result of OCS oil/gas-related onshore construction of about 7 service bases, 13 pipeline landfalls, 4 pipeline storage and coating yards, 180 miles of onshore pipeline, 5 platform fabrication yards, and 5 gas processing plants (USDI, MMS, 1987b). These onshore oil/gas facilities will require about 4,875 acres. Cumulative Federal OCS sulphur-related activity is estimated to result in 2 pipeline lands, 20 miles of onshore pipeline, and up to 12 platforms. Onshore facilities will require about 20-30 acres.

Impacts not related to OCS sulphur activities include the loss of habitat to commercial, military, recreational, and residential construction. Dredging and draining of wetland areas along migratory flyways, in coastal feeding areas, and overwintering areas causes additional habitat loss. Entanglement in commercial and recreational fishing gear causes injury/death to birds. Entanglement and/or ingestion of marine debris and trash (particularly plastic materials) may cause injuries or death of birds. Coastal storms and hurricanes cause flooding and destruction of nesting areas resulting in coastal and marine bird losses. High levels of oil and organic chemical contamination in the river runoff into the northern Gulf of Mexico could cause direct mortality or cause indirect food loss to avian species. Collision with power lines and supporting towers causes additional bird mortality (Avery et al., 1980). These impact producing factors, in aggregate, are judged to result in a moderate (but not readily quantifiable) amount of adverse effects on coastal and marine birds by the destruction, alteration, and/or disturbance of feeding and overwintering areas, and injury and mortality of numerous individual coastal and marine birds.

Conclusion

The cumulative impact on coastal and marine birds in the CPA is estimated to be moderate.

h. Impacts to Adjacent Existing Oil and Gas Operations

Salt domes have provided the enhanced thermal regime for the formation of hydrocarbons, and have formed traps around their flanks for hydrocarbon accumulation. Therefore, many of the bidding units offered in this proposal have existing oil and gas infrastructure (pipelines and platforms) associated with them. Existing oil and gas infrastructure on each bidding unit is shown on Figures IV-2 through IV-13.

Sulphur operations expected to result from this proposed sale would be so small compared to oil and gas operations in the Central GOM that any impacts to the oil and gas industry as a whole would be negligible. However, if sulphur-related activities were to proceed without mitigation, potential adverse impacts to adjacent oil and gas infrastructure could occur during the exploration, development, or production phases of sulphur operations. The production phase of sulphur mining would pose the greatest threat to nearby oil and gas platforms and pipelines due to subsidence. The definitions of impact levels for adjacent existing oil and gas operations are defined in Table S-3.

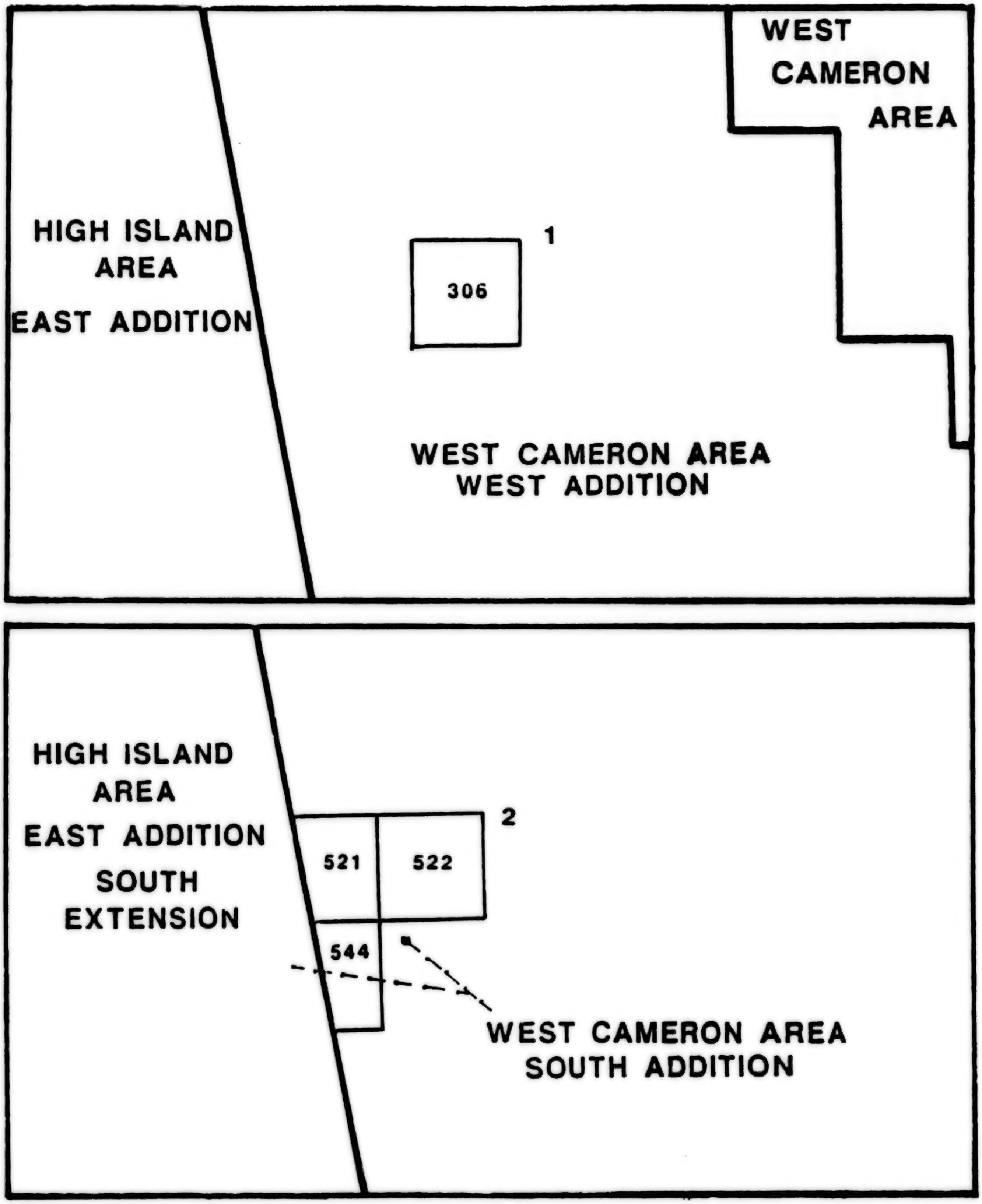
Impact Analysis

The potential adverse impacts to adjacent oil and gas operations posed during the exploration and development phases of sulphur mining would be the threat of physical damage to pipelines by the location of drilling rigs, platform placement, or anchors used during operations or construction. The physical presence of any drill rigs, platforms, and support vessels could have adverse impacts on oil and gas operations (see Section IV.A.3.d.). During the development phase of sulphur mining operations, the injection of high-temperature brine into the cap rock could cause corrosion or overpressuring of any oil or gas well casings penetrating the mining zone, thereby resulting in failure.

The removal of cap rock sulphur during the production phase leaves cavities in the cap rock which can result in subsidence (see Section IV.A.3.f.). Since some sulphur mines have experienced no subsidence, and others have experienced 70 ft or more, an average of 40 ft of subsidence was assumed for each mine resulting from this proposal. Subsidence usually occurs gradually, but can occur rapidly.

Any oil and gas platforms located over the zone being mined for sulphur could be subjected to subsidence. The end result could be structural damage to the platform or its foundation, or its total loss. As one zone of cap rock is depleted, the sulphur production platform is moved to another area of cap rock and it is in turn mined. Thus, any oil and gas platforms and pipelines located over the area where the cap rock lies within 4,000 ft of the surface (considered the maximum feasible depth for Frasch-mining of sulphur) could eventually be subjected to subsidence. If subsidence was gradual, there would be ample warning to avoid an oil spill, injuries, or loss of life. However, the remote possibility exists that such subsidence could be catastrophic in nature.

Any pipelines crossing potential zones of subsidence could be subjected to adverse impacts. Subsidence of the seafloor beneath a pipeline could result in failure due to stress caused by differential support, or could result in


WEST CAMERON AREA
HIGH ISLAND AREA EAST ADDITION
1
306
WEST CAMERON AREA WEST ADDITION
HIGH ISLAND AREA EAST ADDITION SOUTH EXTENSION
2
521
522
544
WEST CAMERON AREA SOUTH ADDITION

■ Major Platforms
□ Small Platforms or Single Well Jackets
— - — Pipelines or Flowlines

Figure IV-2. Existing Oil and Gas Infrastructure - West Cameron Area Tracts.

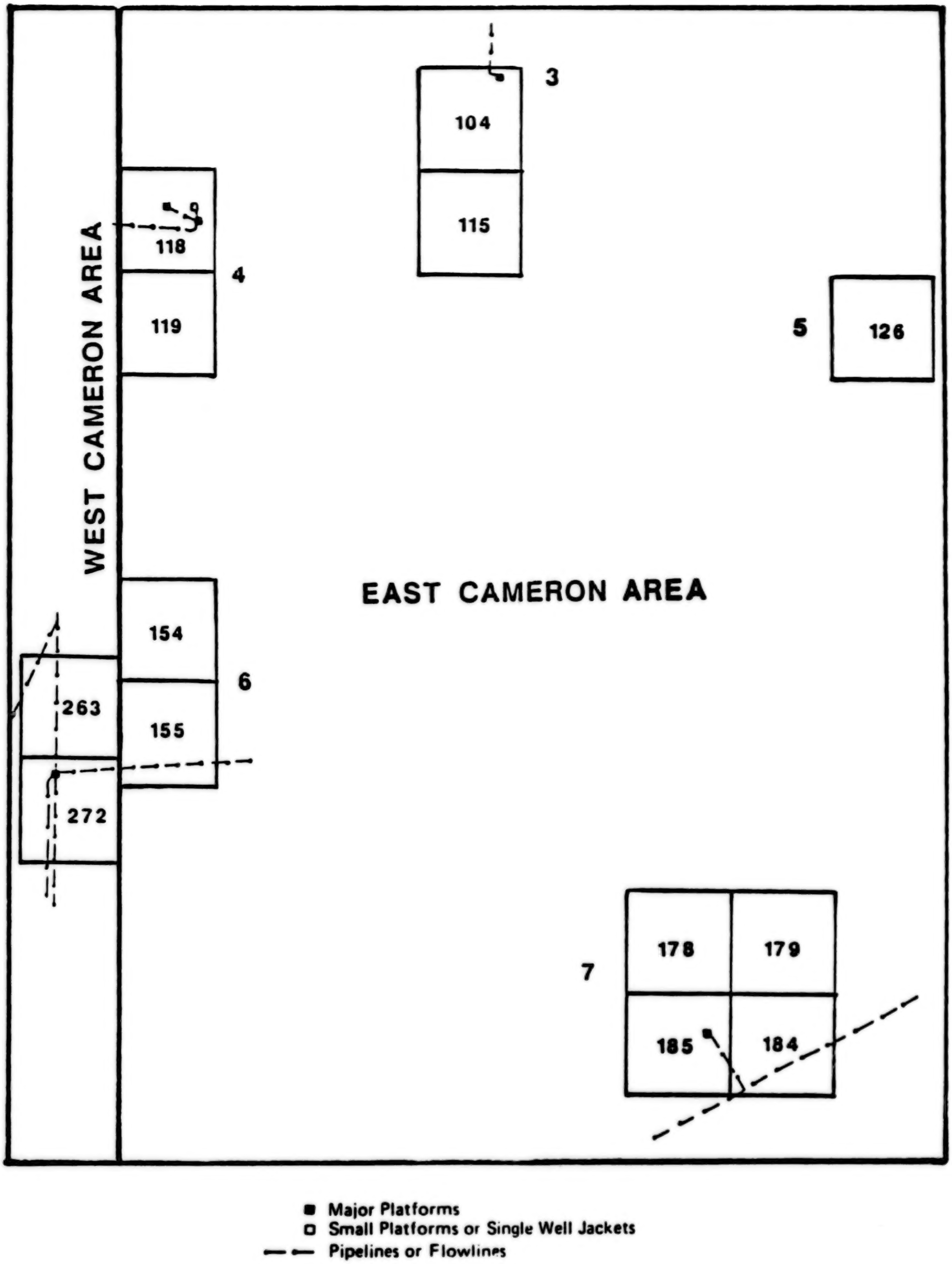


Figure IV-3. Existing Oil and Gas Infrastructure - East Cameron/West Cameron Area Tracts.

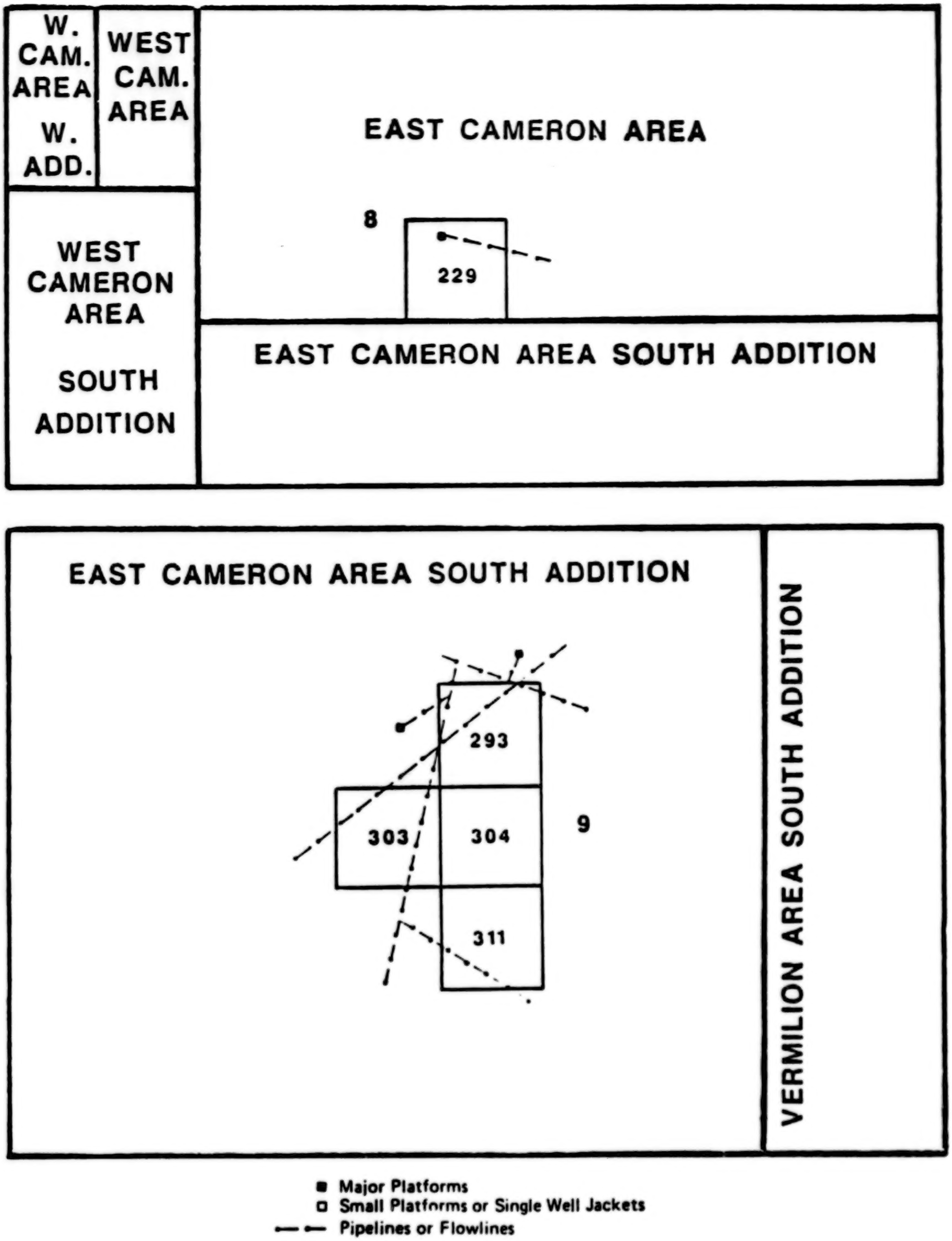

W. CAM. AREA W. ADD.
WEST CAM. AREA
EAST CAMERON AREA
8
229
WEST CAMERON AREA SOUTH ADDITION
EAST CAMERON AREA SOUTH ADDITION
EAST CAMERON AREA SOUTH ADDITION
293
303
304
9
311
VERMILION AREA SOUTH ADDITION
■ Major Platforms
□ Small Platforms or Single Well Jackets
—•— Pipelines or Flowlines

Figure IV-4. Existing Oil and Gas Infrastructure - East Cameron/West Cameron Area Tracts.

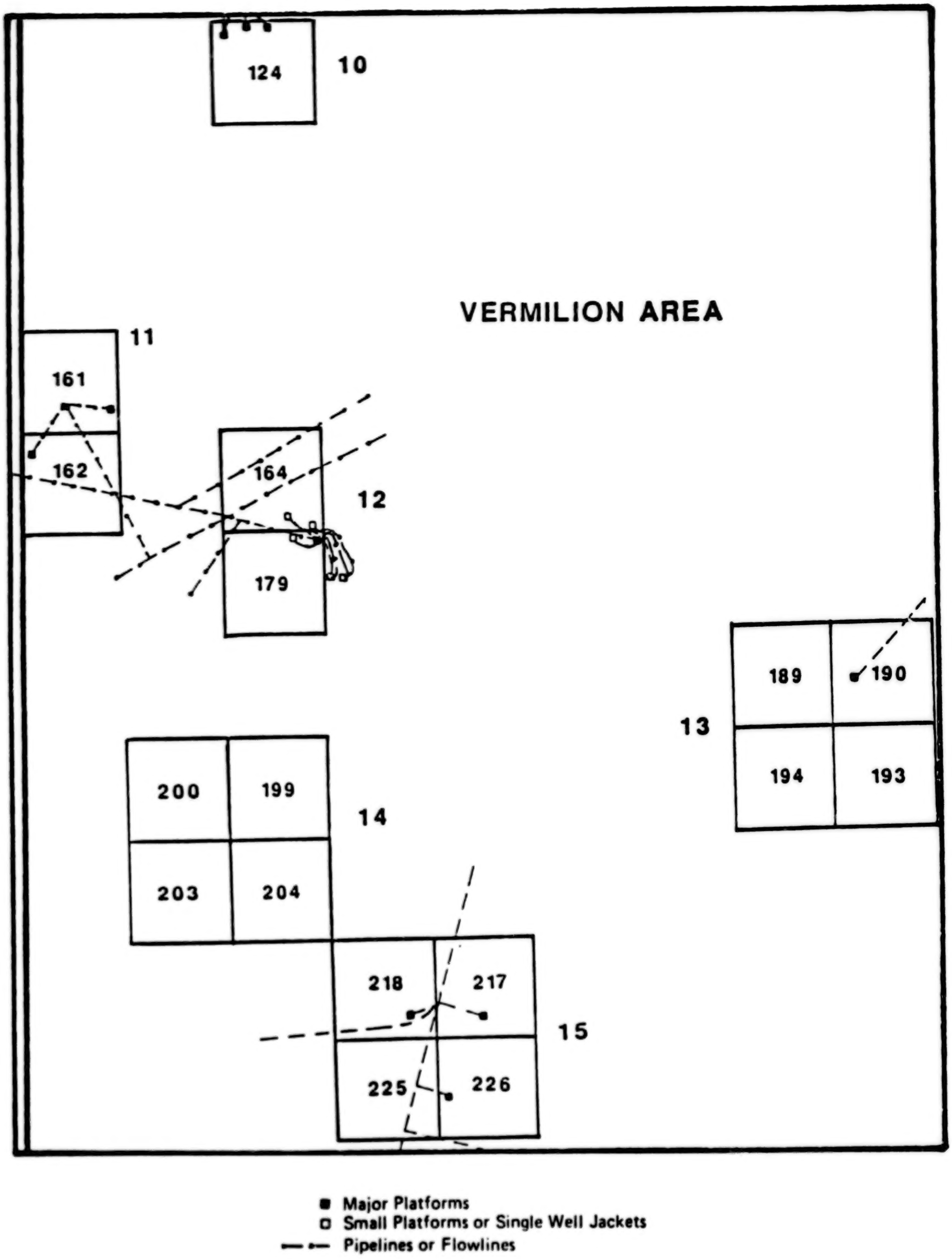


Figure IV-5. Existing Oil and Gas Infrastructure - Vermilion Area Tracts.

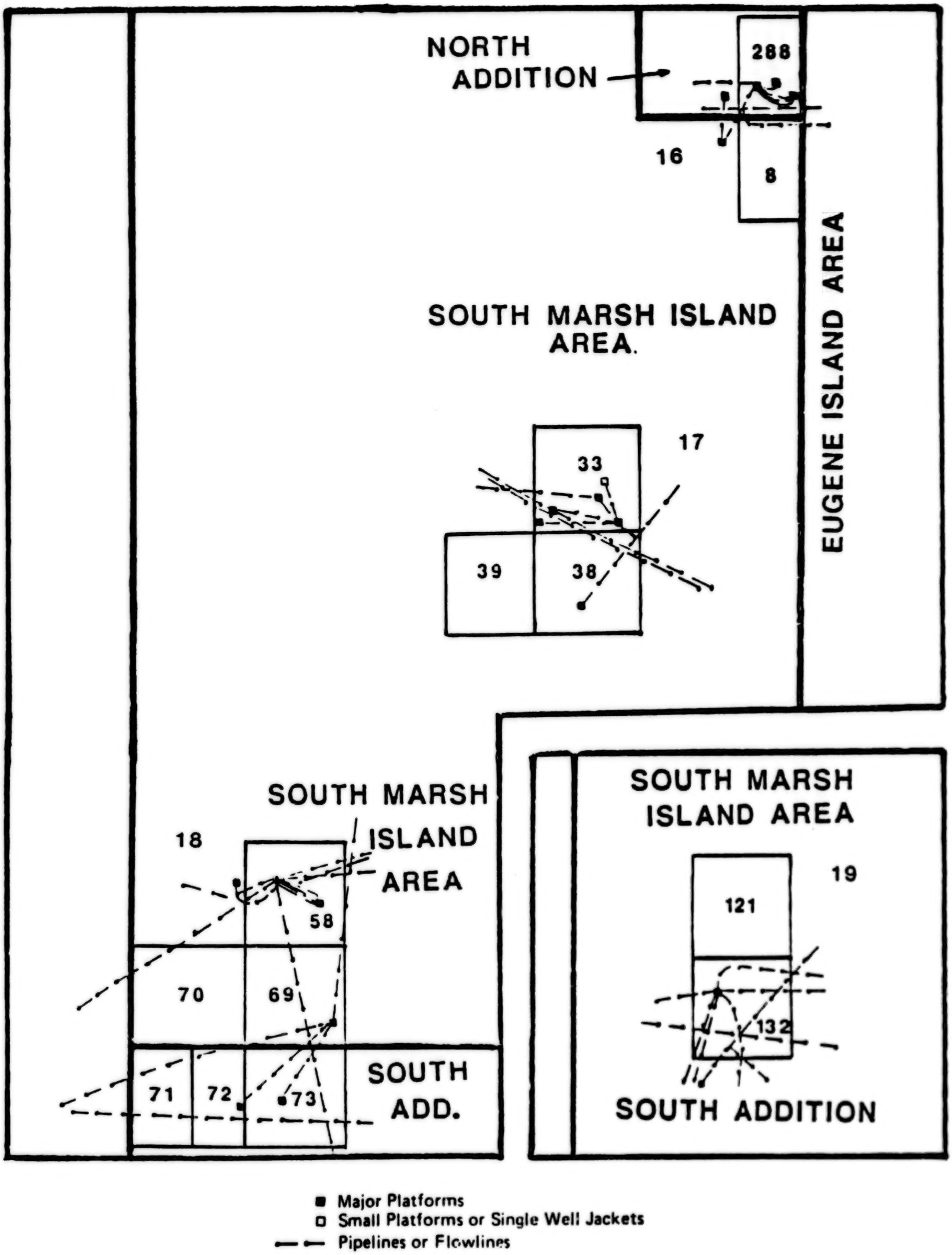
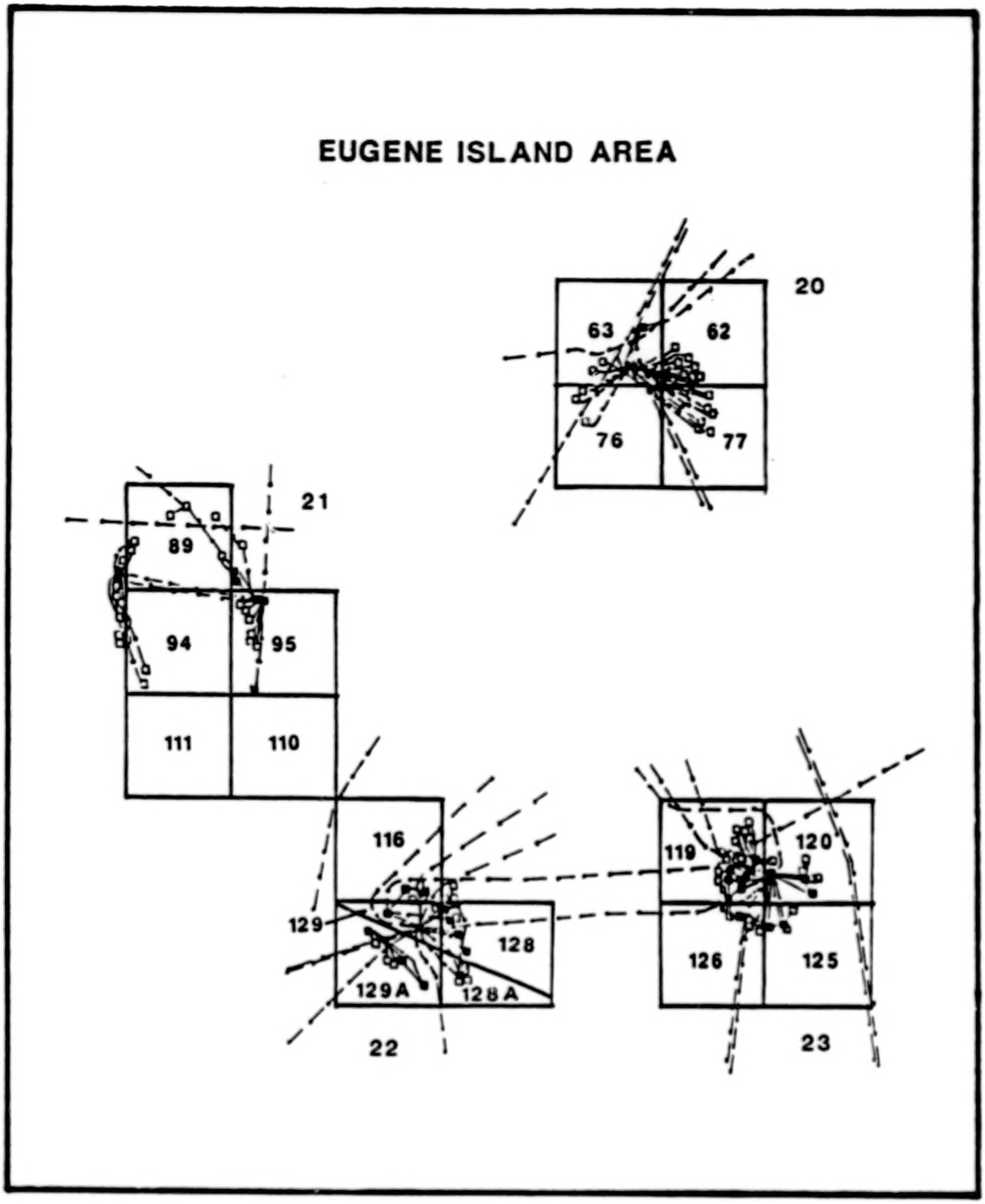
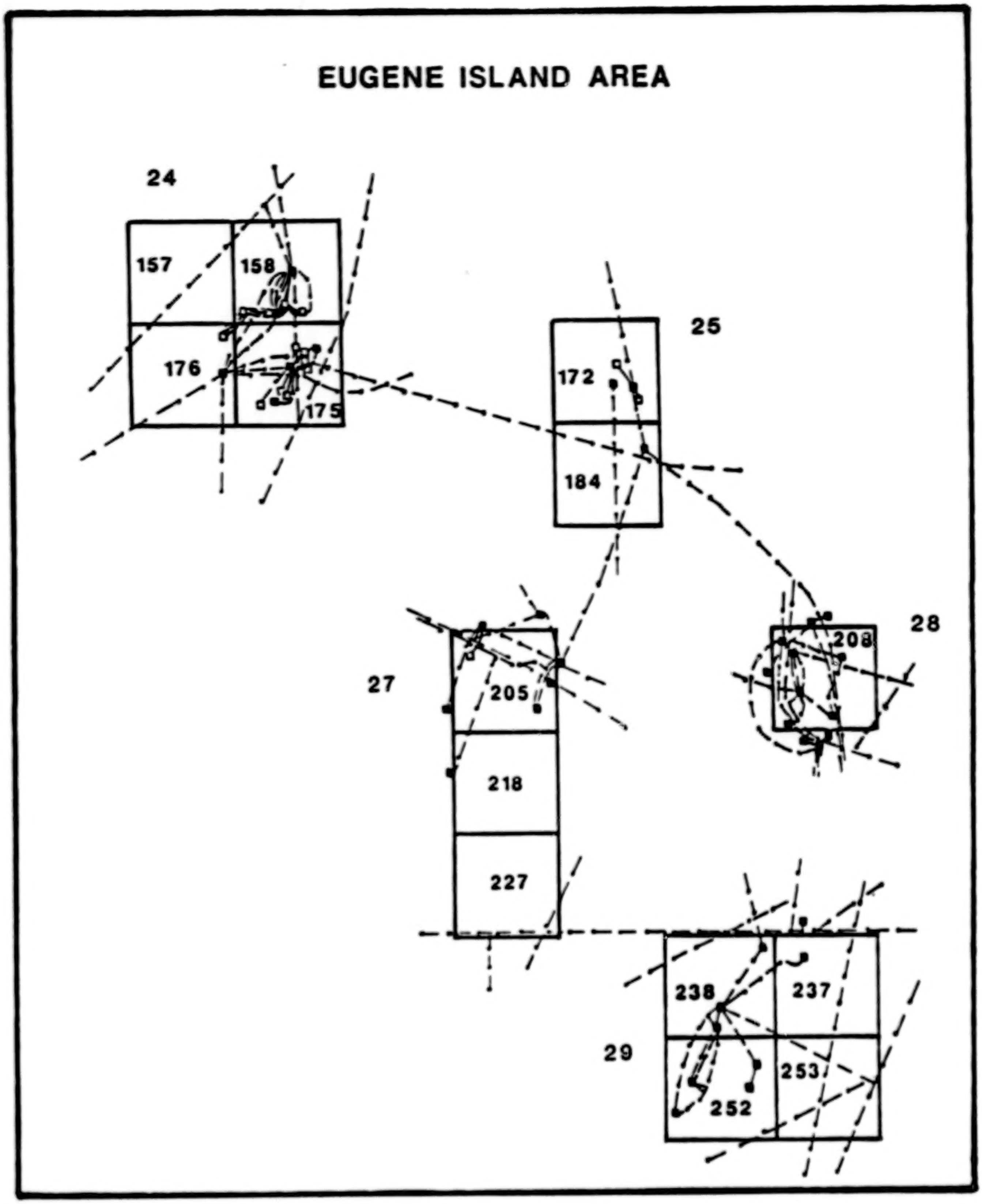


Figure IV-6. Existing Oil and Gas Infrastructure - South Marsh Island Area Tracts.



■ Major Platforms
□ Small Platforms or Single Well Jackets
— — Pipelines or Flowlines

Figure IV-7. Existing Oil and Gas Infrastructure - Eugene Island Area Tracts.



■ Major Platforms
□ Small Platforms or Single Well Jackets
—•— Pipelines or Flowlines

Figure IV-8. Existing Oil and Gas Infrastructure - Eugene Island Area Tracts.

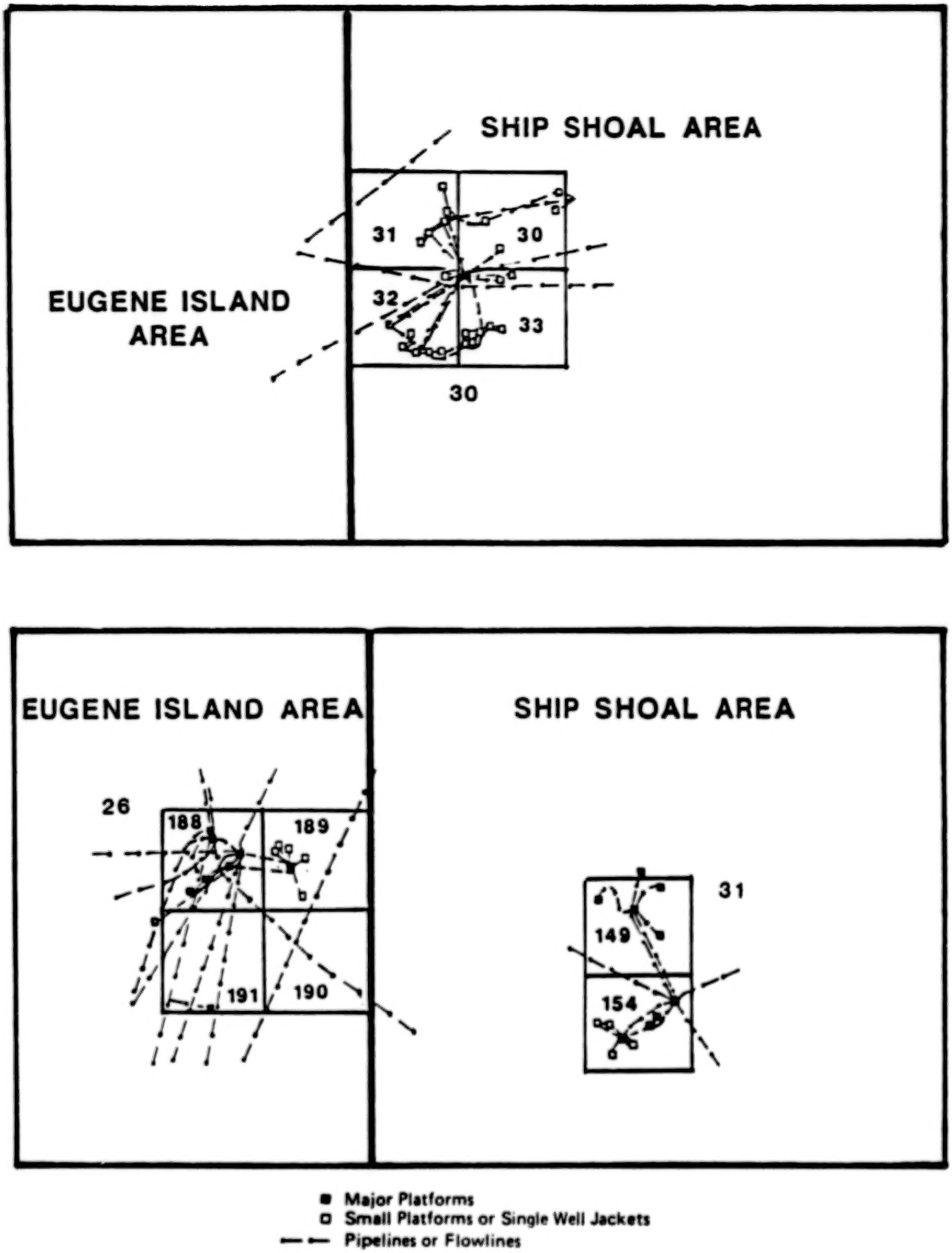


Figure IV-9. Existing Oil and Gas Infrastructure - Ship Shoal/Eugene Island Area Tracts.

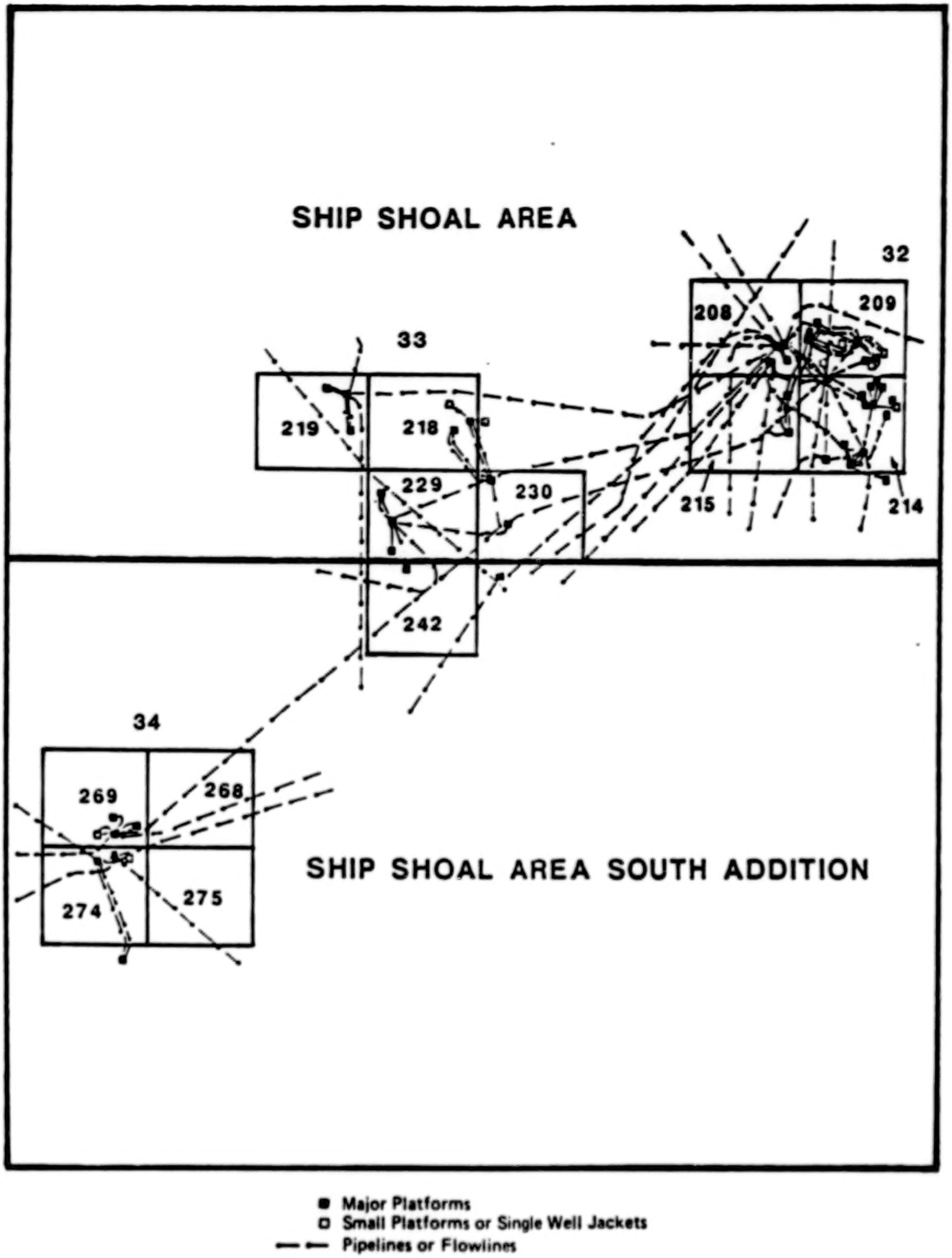

SHIP SHOAL AREA
32
208
209
33
219
218
229
230
215
214
242
34
269
268
274
275
SHIP SHOAL AREA SOUTH ADDITION
■ Major Platforms
□ Small Platforms or Single Well Jackets
— — Pipelines or Flowlines

Figure IV-10. Existing Oil and Gas Infrastructure - Ship Shoal Area Tracts.

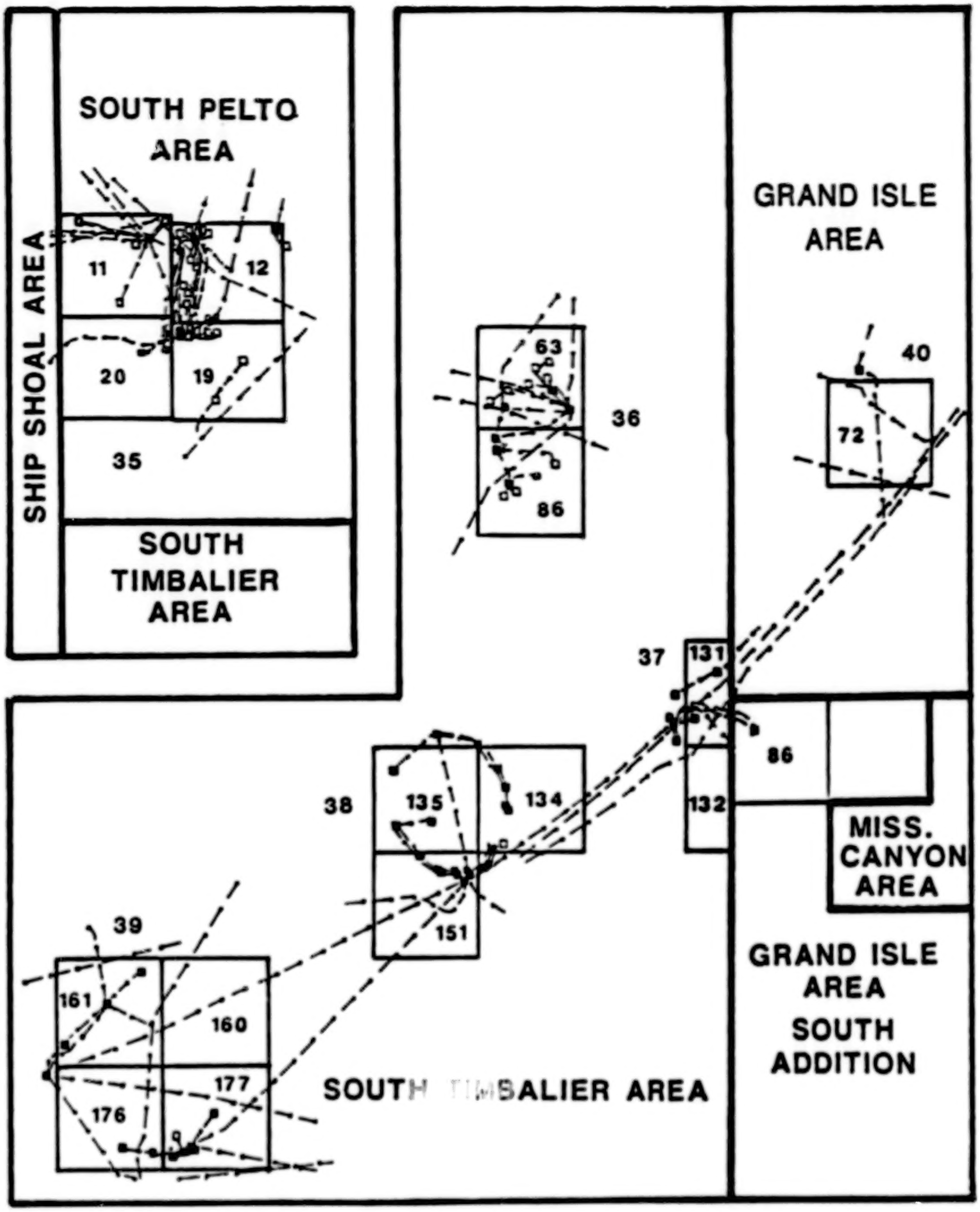


Figure IV-11. Existing Oil and Gas Infrastructure - South Pelto/South Timbalier/Grand Isle Area Tracts.

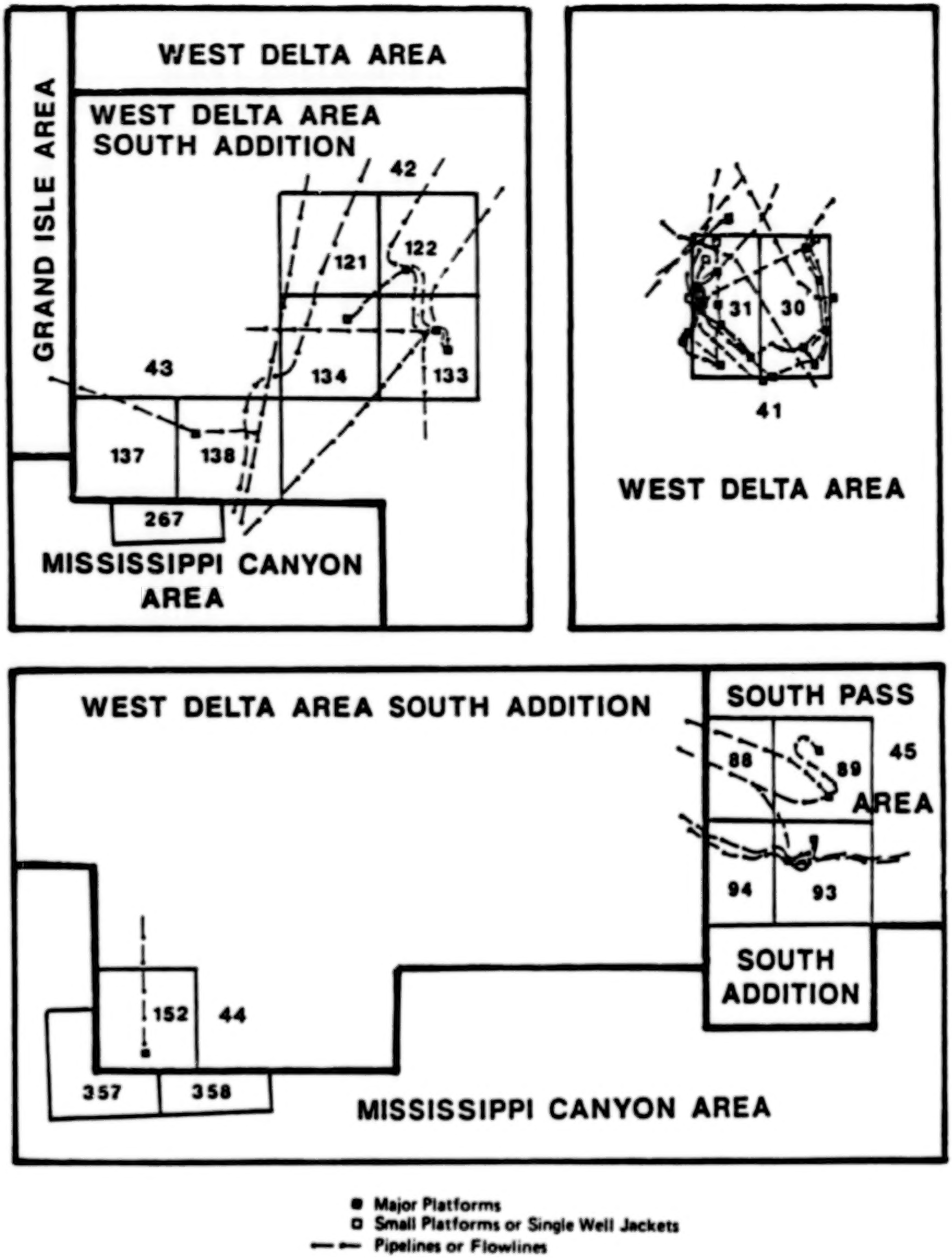


Figure IV-12. Existing Oil and Gas Infrastructure - West Delta/Mississippi Canyon/South Pass Area Tracts.

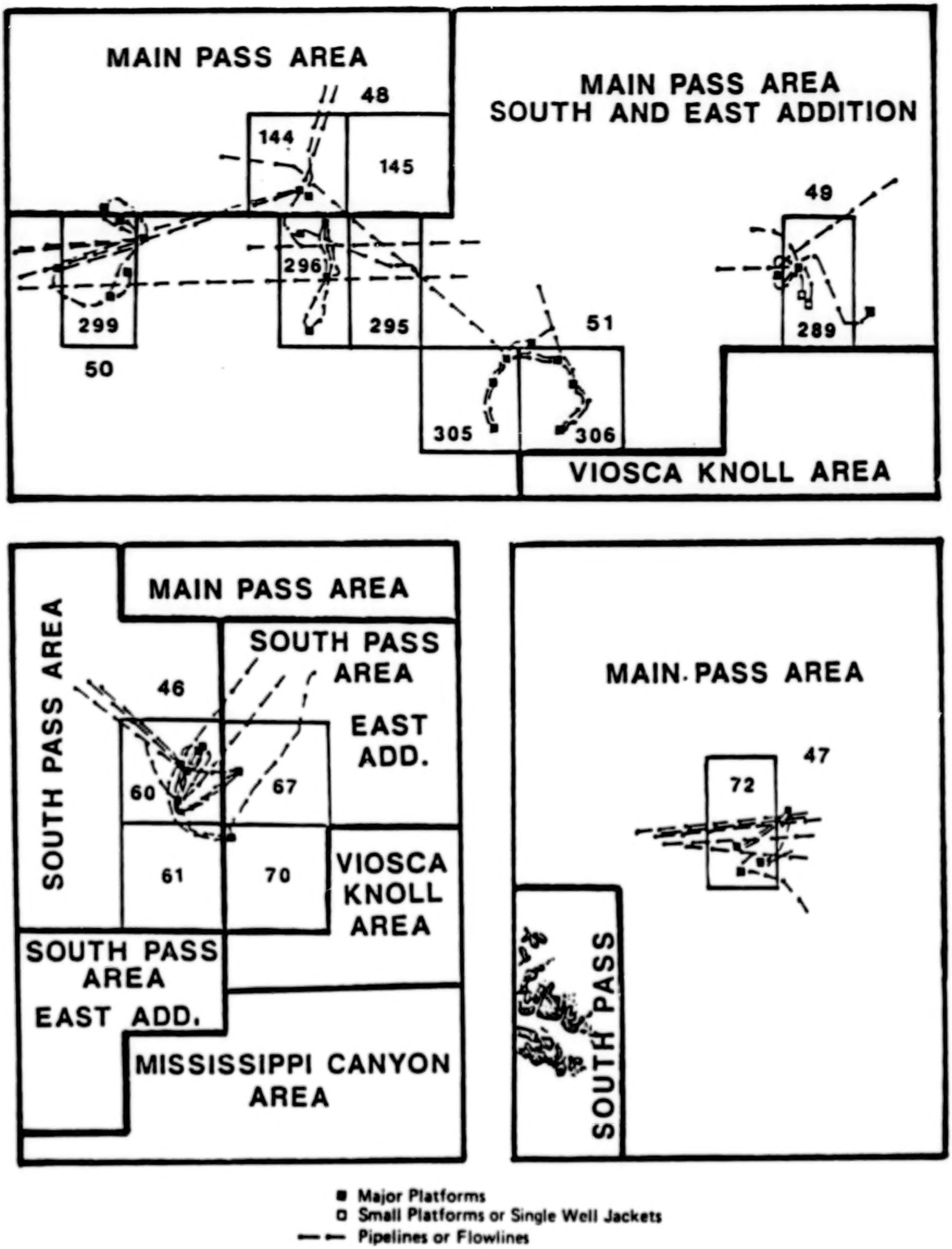


Figure IV-13. Existing Oil and Gas Infrastructure - Main Pass/South Pass Area Tracts.

bridging; thereby exposing the pipeline to damage from trawl gear or anchors, or to failure by stress caused either by vortex shedding from currents or from the unsupported weight. Such a failure could result in an oil spill of small to moderate magnitude. Automatic shut-in and other safety equipment required on OCS pipelines would prevent a major oil spill.

An analysis was undertaken to rate the bidding units as to their potential for impacts to adjacent oil and gas infrastructure from subsidence caused by sulphur mining activity. Pipelines, flowlines, major platforms, and single well jackets or small platforms were plotted at 1:24,000 scale for each block in this proposal. The existing or permitted oil and gas infrastructure was scaled down and is presented in Figures IV-2 through IV-13 by bidding unit.

Using MMS proprietary geophysical and well data, an outline of salt (which would represent the maximum extent of the occurrence of sulphur-bearing cap rock) down to approximately 4,000 ft was plotted on the infrastructure maps. These outlines represent the maximum extent of the zone of potential subsidence. In order to provide a rating system as to the potential for conflict, points were assigned to each pipeline, flowline or platform which occurs inside of the zone of potential subsidence. Points were totaled with a weighing factor to arrive at the high, moderate or low levels for potential impact to existing oil and gas facilities for each bidding unit. The results are shown in Table IV-12 in order of decreasing level of potential impact.

As discussed in Section II.A.3., sufficient authority is afforded MMS to apply the necessary mitigating measures to avert any adverse impacts to adjacent oil and gas infrastructure posed by future sulphur operations. The potential for physical damage to pipelines by the placement of drilling rigs, and other activities associated with exploration for sulphur, will be assessed during the review process of Plans of Exploration as required by 30 CFR 250.34-1. All existing pipeline locations are known and the sulphur-exploratory well locations will be compared to the existing or permitted pipeline locations to avoid physical damage. Each sulphur lessee will also be provided with the pipeline locations in order that they may be avoided by anchors and other exploration-related activity.

Corrosion or overpressuring of any oil or gas well casings penetrating the sulphur-bearing zone due to injection of high-temperature brine will be averted by restricting sulphur mining activities in those areas where oil and gas wells would be affected. MMS has locations of all well bores drilled on the OCS, and these will be compared to the zones of production submitted by the sulphur lessee in his Plan of Development and Production.

Physical damage to pipelines during development drilling for and production of sulphur will be avoided in the manner described above (for exploration activities) at the time of submission of the Plans of Development and Production as required by 30 CFR 250.34-2. The greatest potential impacts to adjacent oil and gas operations (due to the threat of subsidence) will also be addressed during the review of Plans of Development and Production. The lessee is required to submit a detailed map of the prospective ore body to be mined and the planned well locations for each stage of production. From the well locations, zones of potential subsidence can be determined. Potential impacts to those platforms or pipelines can be avoided by one or more means on a case-by-case basis. These measures would include, but are not limited to, delaying sulphur operations in the area of any existing or permitted platforms or pipelines until they are no longer in service and are removed, establishment of a "buffer" zone around any platforms or pipelines so that they will not be affected by subsidence, and relocation of any pipelines or platforms prior to sulphur operations.

Although a potential for conflicts exists between sulphur operations and oil and gas operations, authority granted under 30 CFR 250 will allow MMS to review all plans of operation for various stages of sulphur mining activity and to impose any mitigation necessary to avoid adverse impacts. Thus, impacts to adjacent existing or permitted oil and gas infrastructure is estimated to be very low.

Although MMS has the authority granted under various parts of 30 CFR 250 to prevent adverse impacts to adjacent oil and gas operations, and thereby avoid environmental damage due to oil spills which might result, the formulation of specific provisions in the form of an NTL, LTL, OCS Orders, or an operational constraints stipulation would offer additional mitigation, would reduce even further the potential for impacts to existing oil and gas operations, and would serve to inform lessees what actions might be expected of them in order to avoid any adverse impacts to adjacent oil and gas infrastructure.

Conclusion

With the authority granted MMS under 30 CFR 250, and the implementation of those regulations through NTL's, LTL's, OCS Orders, and lease stipulations, the level of impact to adjacent existing or permitted oil and gas operations from the proposed action is estimated to be very low.

Table IV-12

Potential Impact Levels to Existing Oil and Gas Infrastructure

Bidding Unit	No. of Tracts	Area	Blocks	Level of Impacts	Gas* P/L	Cond. P/L	Oil* P/L	Platforms
23	4	EI	119, 120, 125, 126	High	3	0	82	2
22	5	EI	116, 128, 128A, 129, 129A	High	30	0	3	4
46	4	SP	60, 61, 67, 70	High	9	1	5	2
30	4	SS	30, 31, 32, 33	High	10	0	6	1
32	4	SS	208, 209, 214, 215	High	8	0	3	1
33	5	SS	218, 219, 229, 230, 242	High	3	0	6	0
24	4	EI	157, 158, 175, 176	High	2	0	5	1
37	3	ST/GI	131, 132/86	High	3	0	3	2
20	4	EI	62, 63, 76, 77	High	11	0	0	0
50	1	MP	299	High	2	0	4	0
42	4	WD	121, 122, 133, 134	High	2	1	3	0
26	4	EI	188, 189, 190, 191	High	1	0	4	0
35	4	PL	11, 12, 19, 20	High	3	0	3	0
45	4	SP	88, 89, 93, 94	High	2	0	3	0
36	2	ST	63, 86	High	2	0	3	0
29	4	EI	237, 238, 252, 253	Mod.	2	0	2	0
34	4	SS	268, 269, 274, 275	Mod.	2	0	2	0
25	2	EI	172, 184	Mod.	2	0	2	0
31	2	SS	149, 154	Mod.	3	0	1	0
48	4	MP	144, 145, 295, 296	Mod.	1	0	2	0
38	3	ST	134, 135, 151	Mod.	2	0	0	1
21	5	EI	89, 94, 95, 110, 111	Mod.	2	0	1	0
12	2	VR	164, 179	Mod.	4	0	0	0
18	6	SM	58, 69, 70, 71, 72, 73	Mod.	0	0	4	0
15	4	VR	217, 218, 225, 226	Mod.	4	0	0	0
41	2	WD	30, 31	Low	2	0	1	0
28	1	EI	208	Low	0	0	2	0
47	1	MP	72	Low	0	0	2	0
11	2	VR	161, 162	Low	3	0	0	0
40	1	GI	72	Low	1	0	1	0
39	4	ST	160, 161, 176, 177	Low	1	0	1	0
17	3	SM	33, 38, 39	Low	3	0	0	0
16	2	SM	8, 288	Low	2	0	0	0
9	4	EC	293, 303, 304, 311	Low	2	0	0	0
27	3	EI	205, 218, 227	Low	2	0	0	0
13	4	VR	189, 190, 193, 194	Low	1	0	0	0
6	4	EC/WC	154, 155/263, 272	Low	0	0	0	0
4	2	EC	118, 119	None	0	0	0	0
19	2	SM	121, 132	None	0	0	0	0
1	1	WC	306	None	0	0	0	0
10	1	VR	124	None	0	0	0	0
5	1	EC	126	None	0	0	0	0
43	3	WD/MC	137, 138/267	None	0	0	0	0
44	3	WD/MC	152/357, 358	None	0	0	0	0
14	4	VR	199, 200, 203, 204	None	0	0	0	0
3	2	EC	104, 115	None	0	0	0	0
8	1	EC	229	None	0	0	0	0
7	4	EC	178, 179, 184, 185	None	0	0	0	0
49	1	MP	289	None	0	0	0	0
2	3	WC	521, 522, 544	None	0	0	0	0
51	2	MP	305, 306	None	0	0	0	0

* Large numbers indicate bundles of multiple flowlines

EC - East Cameron
EI - Eugene Island
GI - Grand Isle
MC - Mississippi Canyon
MP - Main Pass
PL - South Pelto
P/L - Pipelines
SM - South Marsh
SP - South Pass
SS - Ship Shoal
ST - South Timbalier
VR - Vermilion
WC - West Cameron
WD - West Delta

Cumulative Impacts

This cumulative analysis considers the effects of impact producing factors related to the proposed action plus those related to prior, proposed, and future OCS oil/gas activities, other governmental and private projects/activities, and pertinent natural processes and events that may occur and adversely affect oil and gas operations in the same general area that may be affected by sulphur activity located in the CPA. Specific types of impact producing factors considered in the analysis include physical presence of drill rigs, platforms, pipelines, support vessels, and construction activity; subsidence associated with sulphur mining activity; hazardous geological conditions; and natural phenomena such as major storms and hurricanes.

There are some 2,800 existing platforms in the CPA. Another 2,560 exploration and delineation wells are projected for the CPA as a result of future OCS minerals development. there are 13,466 miles of offshore pipelines in the CPA, and another 2,400 miles of pipeline are projected as a result of future OCS development. With the current and projected levels of activity, the potential for impacts to existing oil and gas activity from minerals exploration, development, production, and related construction and vessel activity in the vicinity of any sulphur operations resulting from this proposal is moderate.

The likelihood of subsidence related to sulphur operations, and its potential impacts, are discussed above. The cumulative impacts related to subsidence alone would not change substantially from the previous discussion.

Natural phenomena are by far the most important cumulative impact producing factors to existing oil and gas infrastructure. These phenomena include hazardous geologic conditions and tropical cyclones. Several platforms have been lost and numerous pipeline breaks have been recorded due to hazardous geologic conditions in the Gulf of Mexico. Many of these losses occurred around the mouth of the Mississippi River in areas of unstable sediments and resulted from submarine mudslides. Shallow, high-pressure gas deposits have caused blowouts which resulted in the loss of drilling rigs or platforms. These impacts will likely continue to occur to the oil and gas industry operating in the Gulf of Mexico.

About half of the coast along the Central Gulf was hit by 16-20 tropical cyclones between the years of 1901-1955 (DeWald, 1980). The other half, between Atchafalaya Bay in Louisiana and the Texas border, had a slightly lower incidence of cyclones (11-15). Seven major hurricanes also crossed the CPA between the years of 1954-1977. Major storms such as these historically have resulted in both major damage to or the total loss of drill rigs, platforms and pipelines, which in turn has resulted in associated oil spills, injury and loss of life. These types of impacts to the offshore oil and gas industry will likely continue to occur in the Gulf of Mexico.

Although cumulative impacts to adjacent oil and gas operations resulting from the proposed action is very low, overall cumulative impacts to oil and gas infrastructure adjacent to sulphur operations, as well as the offshore oil and gas industry as a whole, is estimated to be very high, primarily due to the impacts caused by natural phenomena.

Conclusion

The overall level of cumulative impact on the adjacent existing oil and gas infrastructure in the Gulf of Mexico is estimated to be very high.

i. Impacts on the Commercial Fishing Industry

The definitions of impact levels for the commercial fishing industry are defined in Table S-3.

Impact Analysis

The impact producing factors on fishing activities from the proposed action would be production platforms, platform removal by explosives, sulphur spills, oil spills, drilling and production discharges, and underwater obstructions such as pipelines and debris.

One production platform eliminates 3-5 acres of trawling space. Up to 18 platforms are expected to result from the proposed action. From 54-90 acres of trawling area would be eliminated, representing less than 0.1% of the available trawling area in the CPA. This would result in a very low impact. (Refer to Section IV.D.1.a.(8) of Draft EIS 113/115/116 for the impact analysis assumptions.

The removal of platforms by explosives has caused mortality of a commercial fishing species. A fish kill comprised of 80%-90% red snapper was observed after explosives were used to remove a platform. The magnitude of this problem has not been studied. A loss of fishing area for snapper hook-and-line fishing (Ditton and Auyong, 1984) and an increase in trawling area would occur as a result of structure removal (USDI, MMS, 1987). If rig removal by explosives is continued unmitigated, it could potentially impact the commercial fishing industry around rigs.

There is a slight possibility of a sulphur spill resulting from the proposed action. Such a spill would have a minimal impact on commercial fish species, but could eliminate a small local trawling area until cleanup was accomplished. Bottom dwelling organisms such as shrimp, crabs, or scallops in the vicinity of a sulphur spill cold be adversely impacted.

There is a slight possibility of an oil spill resulting from the proposed action. Crude oil is frequently associated with the salt dome where sulphur is mined. If a spill occurred, it could cause mortality of eggs and larvae of commercially important species. Also, if the spilled oil were to contact a nursery area (bays and estuaries) within 10 days, some damage to these areas would occur. Since the possibility of a spill is remote, the impact would be very low.

Drilling and production discharges include muds and cuttings similar to those used in oil and gas operations and bleedwater containing sulfide. Impacts of drilling muds to marine fishes are very low (Section IV.D.1.a.(8) of Draft EIS 113/115/116). The toxicity of sulfide is derived from hydrogen sulfide. The sulfide in the area of the bleedwater discharge is mostly in the form of hydrosulfides due to the higher pH of the seawater. Hydrosulfides are readily oxidized to sulfates due to abundance of dissolved oxygen in seawater. The toxicity of sulfides discharged in bleedwater to eggs and larvae of commercial species is, therefore, assumed to be low.

Underwater obstructions such as pipelines and debris cause gear conflicts which result in losses such as trawls, shrimp catch, business downtime, and vessel damage. Financial losses from year conflicts are covered by the Fishermen's Contingency Fund.

Conclusion

The level of impact on the commercial fishing industry is estimated to be very low.

Cumulative Impacts

This cumulative analysis considers the effects of impact producing factors related to the proposed action plus prior and future OCS sales, State offshore oil and gas activity, crude oil imports by tanker, and offshore recreational fishing that may occur and adversely affect the commercial fishing industry in the same general area that may be affected by OCS sulphur activity located in the CPA. Specific types of impact producing factors considered in the analysis include oil spills, offshore oil and gas or sulphur platforms, commercial fishing techniques/practices, space use conflicts, and wetlands loss.

The 18 (in 3 to 4 separate locations) additional platforms resulting from the proposed action plus additional platforms from prior and future OCS oil and gas sales in the CPA (Table IV-8 of Draft EIS 113/115/116) are estimated to reduce trawling area in the CPA by 990-1,650 acres or less than 0.1%. This loss of trawling area should result in a very low impact.

The probability of one or more large oil spills from OCS oil and gas operations (1,000 bbls or greater) contacting open bay/sounds is 99+% (Table IV-35 of Draft EIS 113/115/116). The mean number of spills making contact is 5 (Table IV-8 of Draft EIS 113/115/116). The most likely targets hit would be Vermilion/Atchafalaya Bays, Timbalier Bay, Barataria Bay, and Chandeleur and Breton Sounds/Lake Borgne (Table IV-35 of Draft EIS 113/115/116). The mean number of large spill (1,000 bbls or greater) occurrences in the Gulf is estimated to be 56 (Table IV-8 of Draft EIS 113/115/116). Some of these spills will occur in or affect the CPA. Several smaller spills are expected (99+% probability; Table IV-8 of Draft EIS 113/115/116). Oil spills from sulphur mining activities resulting from this proposal are unlikely. The impact of these cumulative spills on commercial fisheries could be high.

Commercial fisheries in the Gulf of Mexico are also impacted by activities and events other than the oil and gas or sulphur industry. Competition between large numbers of commercial fishermen, between commercial operations employing different fishing methods and between commercial and recreational fishermen for a given fishery resource, may reduce standing populations. Fishing techniques which may take significant numbers of other species as by-catch, such as trawling or gill netting, may reduce the standing populations of these as well as the desired species. Within parts of the Central Gulf, no size or count limits are imposed during certain shrimp seasons, causing overfishing in these areas. Also, shrimpers taking large numbers of fishes in the groundfish complex (croakers being an example of this group) may be contributing to reductions in the numbers of these species. Space use conflicts can result from different forms of commercial operations and between commercial and recreational fisheries. In the Central Gulf, for example, crab trapping and shrimping operations often occur in the same area, resulting in loss of fishing area to one or the other or in gear conflicts when both operations attempt to use the same space. Also, the loss of wetlands are being closely studied to determine in what way and to what extent this loss affects commercial fisheries.

Conclusion

The proposed action, prior and future OCS sales, and other factors added to the widely varying baseline conditions resulting from natural environmental factors, are estimated to result in a high level of cumulative impact on the commercial fishing industry in the Central Gulf area.

j. Impacts on Major Shorefront Recreational Beaches

The five impact levels used in the following analysis of potential impacts on major shorefront recreational beaches are defined in Table S-3.

Impact Analysis

Major recreational beaches are defined as those frequently visited sandy areas along the shorefront exposed to the Gulf of Mexico which support a multiplicity of recreational activity, most of which is focused at the land and water interface. Included are National Seashores, State Park and Recreational Areas, county and local parks, urban beachfronts, and private resort areas. Other than two established State Parks, one at Grand Isle and the other at Cypremort Point, all of Louisiana's other shorefront recreational beaches are managed and maintained at the parish and local levels (Holly Beach) or not at all. Visual No. 3 identifies the major recreational beaches in the CPA and WPA exposed to the Gulf of Mexico.

It may be assumed the proposed sale will result in three new sulphur mines off the Louisiana Coast. Each mine may stay in operation from 20-30 years and involve well drilling, equipment, services, supplies, and offshore construction. As many as 1,500 boat trips per year per mine can be expected. Considering transportation, supplies, services, exploration, and production, as many as 200 people per mine may be added to the offshore work force. Assuming only half those people are offshore at any one time, the proposal will add 300 people working offshore in the Gulf of Mexico. Although considerable debris loads can enter the marine environment from major industrial accidents resulting from natural phenomena (hurricanes, for example), people are the primary use of most chronic debris problems.

It is reasonable to expect that exploration, development, and production of blocks leased in the Central Gulf of Mexico could result in some marine debris from accidents and illegal disposal activities, and the resulting debris or trash could be carried by wind, wave, and currents and eventually impact major shorefront recreational beaches in Louisiana and Texas. Existing OCS regulations, orders, compliance inspections along with new training requirements, and industry and public awareness programs focused on the marine debris and beach litter problems are expected to minimize the level of indiscriminate and irresponsible trash disposal from OCS sulphur operations. Litter impacting recreational beaches from OCS sulphur operations will adversely affect the ambience of the natural beach environment, detract from the enjoyment of beach activities, and can increase administrative efforts on maintained beaches.

Conclusion

The proposed sale is estimated to have a very low impact on the quality and use of major shorefront recreational beaches in Louisiana. No impacts are likely on recreational beaches in Mississippi, Alabama, or Florida; however, persistent debris lost from OCS sulphur operations in the CPA is likely to cause a very low impact on Texas shorefront recreational beaches.

Cumulative Impacts

Besides the proposed sale which is likely to generate up to three new sulphur production sites in the Gulf of Mexico off Louisiana, there are approximately 4,500 active oil and gas leases, 600 discovered oil and gas fields, and over 3,000 active production sites involving as many as 25,000 offshore workers supported by a large fleet of supply, work, and service vessels. Additionally, the merchant shipping industry, commercial fishing industry, and marine recreational industry use the Gulf of Mexico for work and play. All these users can and do contribute to the offshore marine debris problem. Furthermore, contributions of debris from ports, rivers, inland waterways as well as defense operations in the Gulf of Mexico, and foreign sources augment the persistent offshore marine debris load which is contributing to the litter impacting shorefront recreational beaches in the CPA and WPA.

Conclusion

The overall level of impact from all activities occurring, and likely to occur, in and around the Gulf of Mexico to major shorefront recreational beaches in the CPA and WPA is estimated to be high. The incremental effect of beach litter resulting from debris associated with offshore sulphur operations derived from this proposal is expected to be very low.

k. Impacts on Archaeological Resources

Since, in any archaeological site, the most important information is contained in the horizontal and vertical position of an artifact or archaeological feature, in relation to other cultural objects or the natural environment, any activity which disturbs that context may destroy potentially valuable archaeological data.

(1) Historic

Three of the tracts proposed for leasing in this proposed sale contain known shipwrecks: Eugene Island Block 94 is the reported location of the *City of Toledo*, a World War II tanker sunk in 1942; and Eugene Island Block 190 is the location of the *Sheherozada*, a Panamanian tanker also sunk in 1942; and Eugene Island Block 237, the location of the *Hamlet*, also a World War II tanker sunk in 1942. Should these tracts be leased, the impact of the specific development plans on these potentially significant shipwrecks would have to assessed.

Additionally, the following tracts proposed for leasing in this sale are adjacent to a block containing a known shipwreck:

Tract Offered	Shipwreck Location
Vermilion 190	Vermilion 191
Ship Shoal 208	Ship Shoal 207
Ship Shoal 215	Ship Shoal 216
Ship Shoal 218	Ship Shoal 206
Ship Shoal 238	Ship Shoal 216
South Timbalier 151	South Timbalier 136

The effect of proposed development within these tracts (should they be leased) on the shipwrecks reported in the adjacent blocks would have to be assessed at the time the plan of development was submitted.

Although relatively precise locations are known for only 51 potentially significant shipwrecks in the Central Gulf of Mexico (Table III-18 of Final EIS 110/112), a zone of high potential for their occurrence was defined during the archaeological resources baseline study (CEI, 1977).

Impact Analysis

Offshore development could result in an interaction between a drilling rig, platform, pipeline, or anchors and an historic shipwreck. This direct physical contact with a shipwreck site could destroy fragile ship remains, such as the hull and wooden or ceramic artifacts, and could disturb site context. The result would be the loss of archaeological data on ship construction, cargo, social organization of the vessel's crew, and the concomitant loss of information on maritime culture for the time period from which the ship dates. Subsidence after production could result in the same site disturbance as that which would result from direct physical contact.

The Federal Government's involvement in archaeological resource management and production on the OCS is based on the requirements of the National Historic Preservation Act of 1966, as amended, Executive Order 11593, and the OCSLA, as amended (Section I.B.4.d. of final EIS 110/112). Since exact locations of historic shipwrecks cannot be delineated without first conducting a remote sensing survey of the seabed and near-surface sediments, MMS will assure that a survey is conducted prior to development of lease tracts with Archaeological Zone 1.

Generally, in the eastern portion of the Central Gulf where unconsolidated sediments are thicker, it is more likely that shipwrecks present within a survey area would not be detected by the side scan sonar. In this area, which begins around South Marsh Island Area and extends eastward (subplanning areas C-2 and C-3), the effectiveness of the survey in detecting historic shipwrecks of composite and wooden construction would be approximately 25%-30% (Volume 1, Section II.A.1.c.(2), Table II-2 of the Final Regional EIS). Although the potential for a direct physical contact between an impact producing factor and a shipwreck is unknown in this area, the survey would reduce the potential for an interaction by only 25%-30%; therefore, in the eastern portion of the CPA there would still be some potential for a high to very high impact. In the western portion of the Central Gulf where shipwrecks are more likely to be detected by the side scan sonar, the potential for a direct physical contact between an impact producing factor and a shipwreck would be reduced by an estimated 90%. This is such a sufficient reduction in probability that it can be assumed that little damaging interaction between an impact producing factor and a shipwreck site would occur. Therefore, the survey would reduce the potential impact to historic shipwrecks in the western portion of the CPA to very low. Thus, the expected level of impact is very low, except in subareas C-2 and C-3 where the impact is uncertain but could be high to very high. Although the potential impact could be very high in subareas C-2 and C-3 if an interaction occurred, the probability of such an interaction is very low due to the evaluation afforded by other information, including that provided by the requirements in NTL 75-3 (Revision No. 1).

Onshore historic properties include such sites, structures, and objects as historic buildings, forts, lighthouses, homesteads, cemeteries, and battlefields. Sites already listed on the National Register of Historic Places and those considered eligible for the Register (Visual No. 3) have already been evaluated as being able to make a unique or significant contribution to science.

Presently unidentified onshore historic sites may contain unique historic information and would have to be assessed after discovery to determine the uniqueness or importance of the data they contain.

Onshore development as a result of the proposed action could result in direct physical contact between construction of new onshore facilities and previously unidentified historic sites. This direct physical contact with an historic site could cause physical damage to, or complete destruction of, historic sites, structures, and artifacts, and could disturb site context. The result would be the loss of information on the history of the region and the Nation. Often information contained in historical sites is previously undocumented information in written historical accounts and may be the only surviving source of that information.

Due to the visibility of most onshore historic sites, and State and Federal archaeological laws which require consideration of any historic properties if State or Federal funding or permits are required for construction, the expected impact to coastal historic sites in the CPA as a result of the proposed action is assessed as being low.

Conclusion

The expected level of impact to historic sites in the Central Gulf as a result of the proposed action is very low, with the exception of impacts to historic shipwrecks in the eastern portion of the CPA. Here, the potential for an interaction is uncertain, but if an interaction with a significant shipwreck occurs, the impact could be very high. The probability, however, is considered very low.

Cumulative Impacts

This cumulative analysis considers the effects of impact producing factors related to the proposed action plus those related to prior OCS sales, future OCS sales, commercial fishing (trawling), channel construction and maintenance, natural events, tankering of crude oil, recreational diving, commercial exploitation of archaeological artifacts, and other activities that may occur and adversely affect historic archaeological resources located in the CPA. Specific impact producing factors considered in the analysis include trawling, sport diving at archaeological sites, commercial treasure hunting, hurricanes, dredging, platform and pipeline emplacement, oil spills, chronic hydrocarbon inputs to coastal waters, and subsidence related to sulphur operations.

The most intensive areas of trawling in the Central Gulf are represented by the areas outlining the centers of abundance for white shrimp (Visual No. 2). Extensive trawling within these areas would probably only affect the upper 3 inches or so of sediment (NERBC, 1980). Any shipwreck site components within 3 inches of the present seabed probably would be affected should the area be trawled. On many wrecks, this zone would already be disturbed by natural factors and would contain only artifacts of low specific gravity which have lost all original context and have been heavily abraded (Muckelroy, 1978). Therefore, the effect of trawling on most historic shipwreck sites would probably be very low.

Sport diving and commercial treasure hunting are significant factors in the loss of historic data from wreck sites. While commercial treasure hunters generally impact wrecks with intrinsic monetary value, sport divers may collect souvenirs from all types of wrecks. Since the extent of these activities is unknown, the impact cannot be quantified. However, assuming that any of the data lost has been unique, the impact would be very high.

About half of the coast along the Central Gulf was hit with 16-20 tropical cyclones between the years 1901-1955 (DeWald, 1980). The other half, between Atchafalaya Bay in Louisiana and Texas, had a slightly lower incidence of cyclones (11-15). Seven major hurricanes also crossed the Central Gulf between the years 1954-1977. Shipwrecks in shallow waters are exposed to a greatly intensified longshore current during tropical storms (Clausen and Arnold, 1975). Under such conditions, it is highly likely that artifacts of low specific gravities (e.g., ceramics and glass) would be dispersed, leaving only the denser materials (iron, steel, ballast, and conglomerates) at the original site. Some of the original information contained in the site would be lost in this process, but a significant amount of information would also remain. Overall, a significant loss of data from historic sites has probably occurred, and will continue to occur, in the Central Gulf from the effects of tropical storms. Assuming that some of the data lost has been unique, this impact would be very high.

Because most channel dredging occurs at entrances to bays, harbors and ports, there is a high probability for impacts to historic sites because of high site densities in these areas. Assuming that some of the data lost have been unique, the impact to historic sites as a result of past channel dredging activities would be very high. In many areas, COE now requires remote sensing surveys prior to dredging to minimize such impacts.

There are 2,800 existing platforms in the CPA. Another 2,560 exploration and delineation wells are projected for the CPA as a result of future OCS development. There are 13,466 miles of offshore pipelines in the CPA, and another 2,400 miles of pipeline are projected as a result of future OCS development. The first wells were drilled in 1947 prior to enactment of the legislation on which the archaeological resources surveys have been based for the past 12 years. Although information on the chronological distribution of this development is not available for this analysis, development reached its peak after the archaeological survey requirement began. Assuming that the archaeological surveys, which have been required prior to lease development over the past 12 years, have been (on an average) 60% effective in locating historic shipwrecks, the major impacts would have resulted from development prior to 1974. The potential that an interaction between an impact producing factor from offshore development and a significant historic shipwreck either has occurred or will occur is unknown. However, such an interaction could result in the loss of significant or unique historic information. This would cause a high or very high impact to the historic resource base of the CPA.

Besides, up to two pipeline landfalls resulting from this proposal, there are 13 projected pipeline landfalls in the Central Gulf under the cumulative scenario. Since MMS does not permit pipelines in State waters, the archaeological resource protection requirements of the National Historic Preservation Act (NHPA) are not within MMS's jurisdiction. However, other Federal agencies, such as the Corps of Engineers who lets permits associated with pipelines in State waters, are responsible for the protection of archaeological resources under the NHPA. Therefore, the impacts which might occur to archaeological resources by pipeline construction within State waters should be mitigated under the requirements of the NHPA.

There is a high probability (95% chance) that one or more large spills (1,000 bbls or greater) and several smaller spills will occur and contact coastal archaeological sites (historic and prehistoric) under the cumulative scenario. In addition, it has been estimated that the annual input of petroleum into the Gulf from all sources approaches 2.3 million bbls. This chronic hydrocarbon contamination could have an impact on historic resources. However, since the impacts to historic sites from oil contamination are generally short-term and reversible, the expected cumulative impacts from oil contamination would be low.

The likelihood of subsidence related to sulphur operations occurring and its impacts are discussed in above. The cumulative scenario involving subsidence would not change much from the impact analysis.

Conclusion

The overall level of cumulative impact on the historic archaeological resource base in the Central Gulf is estimated to be very high.

(2) Prehistoric

Prehistoric sites which are anticipated to occur offshore include all the types of sites observed onshore, such as shell middens, campsites, kill sites, and tool manufacture areas.

Impact Analysis

Offshore development as a result of the proposed action could result in an interaction between a drilling rig, platform, pipeline, or anchors and an inundated prehistoric site. This direct physical contact with a site could destroy fragile artifacts or site features and could disturb the site context. The result would be the loss of archaeological data or prehistoric migrations, settlement patterns, subsistence strategies, and archaeological contacts for North America, Central America, South America, and the Caribbean. Subsidence after production could result in the same site disturbance as that which would result from direct physical contact.

Likely locations for archaeological sites cannot be delineated without high-resolution seismic data. Data of sufficient resolution are unavailable for most unleased areas of the CPA; therefore, likely site locations cannot be determined prior to conducting a remote sensing survey.

The Federal Government's involvement in archaeological resource management and protection on the OCS is based in the requirements of the National Historic Preservation Act of 1966, as amended, Executive Order 11593, and the OCSLA, as amended (Section I.B.4.d. of final EIS 110/112). Since likely locations of archaeological sites cannot be delineated without first conducting a remote sensing survey of the seabed and near-surface sediments, MMS will assure that a survey is conducted prior to development of lease tracts within Archaeological Resources Zones 1 and 2.

It is estimated that the archaeological survey is 90% effective in allowing identification and avoidance of high probability areas for site occurrence. This provides such a sufficient reduction in the potential for an interaction between an impact producing factor and prehistoric archaeological site, and it can be assumed that little damaging interaction would occur. Therefore, the survey would reduce the potential impact to prehistoric sites in the CPA to very low.

Onshore prehistoric sites include sites, structures, and objects such as shell middens, campsites, kill sites, tool manufacture areas, ceremonial complexes, and earthworks.

Onshore development as result of the proposed action could result in direct physical contact between construction of new onshore facilities and a previously unidentified prehistoric site. This direct physical contact with a prehistoric site could destroy fragile artifacts or site features and could disturb the site context. The results would be the loss of information on the prehistory of North America and the Gulf Coast Region.

Due to State and Federal archaeological laws which require consideration of archaeological resources if any State or Federal funding or permits are required for construction, the expected impact to coastal prehistoric sites in the CPA as a result of the proposed action is very low.

Conclusion

The expected level of impact to prehistoric sites in the Central Gulf as a result of the proposed action is very low.

Cumulative Impacts

This cumulative analysis considers the effects of impact producing factors related to the proposed action plus those related to prior OCS sales, future OCS sales, commercial fishing (trawling), channel construction and maintenance, natural events, tankering of crude oil, recreational diving, commercial exploitation of archaeological artifacts, and other activities that may occur and adversely affect prehistoric archaeological resources located in the

CPA. Specific impact producing factors considered in the analysis include trawling, hurricanes, dredging, platform and pipeline emplacement, oil spills, chronic hydrocarbon inputs to coastal waters, and subsidence from sulphur operations.

The most intensive areas of trawling in the Central Gulf are represented by the areas outlining the centers of abundance for white shrimp (Visual No. 2). Extensive trawling within these areas would probably only affect the upper 3 inches or so of sediment (NERBC, 1980). Due to the limited vertical extent of disturbance associated with trawling, it is unlikely that any prehistoric sites would be affected.

About half of the coast along the Central Gulf was hit with 16-20 tropical cyclones between the years 1901-1955 (DeWald, 1980). The other half, between Atchafalaya Bay in Louisiana and Texas, had a slightly lower incidence of cyclones (11-15). Seven major hurricanes also crossed the Central Gulf between the years 1954-1977. These storms would affect coastal prehistoric sites on barrier islands and beach fronts by erosion and reworking of sediments which would either destroy or change the context of site components. When the number of tropical storms recorded within this century is multiplied by 30 (for sites approximately 3,000 years old), it seems highly likely that many exposed coastal prehistoric sites have been, and will continue to be, destroyed by such storms. Assuming that some of the data lost has been unique, this impact would be very high.

Because most channel dredging occurs at entrances to bays, harbors and ports, there is a high probability for impacts to prehistoric sites because of high site densities in these areas. Assuming that some of the data lost have been unique, the impact to prehistoric sites, as a result of past channel dredging activities, would be very high. In many areas, COE now requires remote sensing surveys prior to dredging to minimize such impacts.

There are 2,800 existing platforms in the CPA. Another 2,560 exploration and delineation wells are projected for the CPA as a result of future OCS development. There are 13,466 miles of offshore pipelines in the CPA, and another 2,400 miles of pipeline are projected for the CPA as a result of future OCS development. The first wells were drilled in 1947 prior to enactment of the legislation on which the archaeological resources surveys have been based for the past 12 years. Although information on the chronological distribution of this development is not available for this analysis, development reached its peak after the archaeological survey requirement began. Assuming that the archaeological surveys, which have been required prior to lease development over the past 12 years, have been 90% effective in identifying areas having a high probability for the occurrence of prehistoric sites, the major impacts would have resulted from development prior to 1974. The potential that an interaction between an impact producing factor from offshore development and a significant prehistoric site either has occurred or will occur is unknown. However, such an interaction would result in the loss of significant or unique archaeological information. This would cause a high or very high impact to the archaeological resource base of the CPA.

Besides up to two pipeline landfalls resulting from this proposal, there are 13 projected pipeline landfalls in the Central Gulf under the cumulative scenario. Since MMS does not permit pipelines in State waters, the archaeological resource protection requirements of the NHPA are not within MMS's jurisdiction. However, other Federal agencies, such as the Corps of Engineers who lets permits associated with pipelines in State waters, are responsible for the protection of archaeological resources by pipeline construction within State waters should be mitigated under the requirements of the NHPA.

There is a high probability (95% chance) that one or more large spills (1,000 bbls or greater) and several smaller spills could occur and contact coastal archaeological sites (historic and prehistoric) under the cumulative scenario. In addition, it has been estimated that the annual input of petroleum into the Gulf from all sources approaches 2.3 million bbls. This chronic hydrocarbon contamination is much more significant in its potential impact on prehistoric resources. The most serious effect of oil contamination is the alteration of the carbon content of organic materials in coastal prehistoric sites. This contamination may result in erroneous C-14 dates and the possible loss of all dating potential for a site. Thus, the loss of significant prehistoric site data could be very high.

The likelihood for subsidence related to sulphur operations and the associated impacts discussed above. The cumulative impacts related to subsidence would not change much from the previous discussion. Impacts to prehistoric sites subjected to subsidence could be high.

Conclusion

The estimated level of cumulative impact on the prehistoric archaeological resource base in the Central Gulf is very high.

I. Socioeconomic Impacts

Section III.C.6. clearly addresses the economic impact of existing sulphur activity in the coastal region. Additionally, Section III.C.5. similarly addresses the offshore oil and gas industry. In analyzing the economic impact of the proposed sale, existing conditions in both of these industries are pertinent.

MMS has analyzed the impacts of the proposed 1987 sulphur/salt lease sale in the Central Gulf of Mexico on local employment, payroll, and population in adjacent coastal regions. The following discussion centers on the direct and indirect impacts specifically associated with proposed sulphur and salt industry activities.

Generically, this analysis is based on the estimation of employment requirements that will result from the proposed sale. This employment estimate will include direct, secondary, and induced labor requirements. Direct employment for this analysis will include workers employed by establishments which are primarily engaged in mining native sulphur. Such establishments are covered under the United States Government's Standard Industrial Classification (SIC) Code 1477. In addition to SIC Code 1477 employment, direct employment estimates will include workers associated with the transportation of sulphur from the mine to a processing or storage facility. Finally, direct employment will also include personnel at shorebase and storage terminals whose primary function is to service the offshore sulphur mining operations. Secondary employment for this analysis will include workers engaged in the manufacturing of sulphur chemicals and allied products. Such employment is covered under SIC Code 2819. Induced labor requirements include jobs which are generated by expenditures of direct and secondary employees. Such jobs result from the demand for consumer goods and services, e.g., food, clothing, housing, entertainment, fuel, etc.

In analyzing the impact of the proposed sulphur sale on regional employment (direct, secondary, and induced), one must compare the sale-related employment requirements to the available supply of labor over the life of the proposed sale. MMS does this by: first, projecting the demand for oil, gas, and sulphur mining workers under the condition of no sulphur sale; second, a peak year of employment under this condition is determined; and third, the difference between employment in the peak year and employment in any given nonpeak year represents the available supply of labor within the region in the given nonpeak year. If the sale-related employment requirements do not exceed the available labor supply in any given year, then no new residents into the region would be expected to result from the proposed sale.

Based on the results of this analysis, the impact measures which are used for conclusions relating to specified impact producing conditions are shown in Table S-3.

In these conclusions, new resident growth is analyzed in proportion to total oil-, gas-, and sulphur-related activity in the region without the proposed sale. Activity from all three sectors is used because it is assumed that labor among these sectors is generally substitutable.

Finally, this analysis implicitly assumes that the net increase in employment created by the proposed lease sale will go to employees currently outside the region. Instead, these opportunities may be used by workers currently in the coastal region who are unemployed, not in the labor force, or employed within non-oil-, gas-, and sulphur-related activity. These occurrences were not quantified due to lack of detailed base information.

Impact Analysis

As previously discussed in Section III.C.6., total sulphur-related employment in 1984 in the region was 4,800. This was based on the following assumptions:

> Direct Employment - SIC 1477 employment plus 80 employees per terminal facility (existing terminals at Port Sulphur and Beaumont).
> Indirect Employment - SIC 2819 employment.
> Induced Employment - Based on the assumption that induced employment is 0.33 times the direct plus indirect employment.

Sulphur-related population for the region is assumed to be 2.3 times the total number of employees in the region, or 11,040. This figure means that for every employee in the sulphur industry, there are 2.3 additional persons in the employee's household.

Also, as discussed in Section III.C.6., the 1984 sulphur-related payroll in the region was $130 million. The payroll multipliers used in that estimate were as follows:

Direct Payroll - $28,000/year/employee (Mickleberry, 1986, personal communication).
Indirect Payroll - $31,000/year/employee (Office of Management and Budget. 1972--County Business Patterns for SIC 2819).
Induced Payroll - $20,000/year/employee (Office of Management and Budget. 1972--County Business Patterns for all industries).

The projected sulphur sale-related employment in the region under similar assumptions would be 5,200 over the life of the project (1989-2022). Specifically, those assumptions are:

Direct Employment - 210 employees for drilling and production activities; 30 employees for transportation activities; 80 employees per terminal; and 7 employees per shorebase. The number of new mines, terminals, and shorebases expected to result from the proposed sale are assumed to be 3 each for this analysis. This assumption considers the expansion of an existing facility as a new activity.
Indirect Employment - The multiplier from the existing ratio of indirect to direct employment was used. The multiplier was rounded to the nearest whole number and is equal to 3.0.
Induced Employment - The multiplier used was 0.33 times direct plus indirect employment.

The peak year (1987) direct oil-, gas-, and sulphur-related employment without the sulphur sale is 81,000 employees. The peak year (1992) oil-, gas-, and sulphur-related employment in the life of the proposed sale is 62,000. Therefore, the sulphur/salt sale will attract no new residents to the region, but instead will only provide employment to existing residents, probably displaced oil and gas workers based on the recent decline of offshore oil and gas activity.

Projected sulphur sale-related population for the region is assumed to be 2.3 times the total number of employees in the region, or 11,960. This figure assumes that for every employee there are 2.3 additional persons in the employee's household.

The projected sulphur sale-related payroll in the region is $145 million over the life of the project (1989-2022). This is based on the same multipliers as above. The projected new resident payroll is expected to be zero.

Conclusion

Based on the level of peak year activity, which occurs in 1992, the impact of the proposed action in the region is expected to be very low.

Cumulative Analysis

This analysis considers the effects of the proposed action, as well as the projected effects of past leasing and other existing employment producing activities (in all industries).

Data on the amounts and historic trends in employment, income, and population in the Gulf Coast states are included in Section III.C. Projections of these three important indicators of economic activity made for this analysis are based on growth trend projections for SMSA's and other substrate areas published in the report, *1980 BEA Regional Projections* (USDC, Bureau of Economic Analysis, 1981) and on an assessment of information on the trends in these indicators through 1982. These projections indicate an average annual growth rate of about 1% for employment, income, and population over the 33-year period 1989-2022 in the analysis area. The proposed action will have a negligible effect on these total average annual growth rates since these sales are expected to result in much less than 1% growths in economic activity in each affected coastal subarea, as previously discussed in this report.

Conclusion

The expected level of cumulative impact on employment, income, and population is estimated to be very low, based on the estimated average annual growth rate of about 1% in the analysis area.

2. Impacts from Alternative B - Delete Tracts with Active Oil and Gas Leases

This alternative would delete 125 of the 153 tracts proposed for this sale.

Impact Analysis

The adoption of this alternative would reduce the potential for interference of existing oil and gas operations by future sulphur operations. By reducing the potential for such conflicts, the remote chances of an accidental oil spill resulting from such conflicts would be even further reduced. By the adoption of this alternative, the size of the proposed sulphur/salt sale would be reduced by some 80%, thus all other impacts to various resources analyzed would be likewise reduced.

The adoption of this alternative would remove the access to a sizable portion of the 55 million long tons of sulphur expected to be discovered and developed as result of this sale, thus continuing this nations dependence on sulphur imports from Canada and Mexico.

Conclusion

The adoption of this alternative would reduce the potential for impacts to existing oil and gas operations from sulphur operations to near zero. All other impacts analyzed would also be reduced due to the reduced size of the sale.

Cumulative Impacts

Cumulative impacts to oil and gas operations would remain the same, principally from other sources than sulphur operations.

3. Impacts from Alternative C - Delete Tracts with Pipelines

This alternative would delete 128 tracts which contain oil or gas pipelines from the 153 tracts proposed for this action.

Impact Analysis

The adoption of this alternative would reduce the possibility of pipeline damage by future sulphur operations. Likewise, the slight chance for oil spills resulting from such damage would be even further reduced. Impacts to all other resources analyzed would also be reduced since the sale would be reduced in size by some 82%.

Adoption of this alternative would remove the opportunity for the discovery and development of a sizable portion of the 55 million long tons of sulphur expected to result from the proposed action.

Conclusion

The adoption of this alternative would reduce the chances of oil spills resulting from pipeline damage by sulphur operations to near zero, and other impacts analyzed would also be substantially reduced.

Cumulative Impacts

The cumulative impacts to pipelines, principally from other sources, would remain the same.

4. Impacts from Alternative D - Delete Military Areas

This alternative would delete one tract from the proposed sale which occurs in a military water test area.

Impact Analysis

The adoption of this alternative would further reduce the liability of the U.S. Government by reducing the slight chance of potential conflicts between future sulphur operations and military rocket and missile testing operations. All impact to various resources analyzed would essentially remain the same.

Conclusion

If the one tract in a military warning area were deleted from the proposed sale, the potential for conflicts between sulphur operations and military operatons would be reduced to near nothing, and all other impacts would remain the same.

Cumulative Impacts

All cumulative impacts would remain essentially the same.

5. Impacts from Alternative E - Delay the Sale

There are no specific issues known at this time which would cause a delay of this sale. It is possible that a delay could occur for reasons that may arise before the sale is held. Delaying the sale would withhold nominated blocks from leasing for an indefinite period of time.

Impact Analysis

All impacts associated with Alternative A would be delayed until such time as the sale is held.

Conclusion

If the sale is delayed, all impacts would be delayed the same period of time.

Cumulative Impacts

Although the impacts of the proposed action would be delayed, the overall levels of cumulative impacts potentially caused by existing and proposed OCS sulphur/salt leasing are expected to be essentially the same as summarized in Section II of this document and described in detail in Section IV.C.1.

6. Impacts from Alternative F - No Action

This alternative is equivalent to cancellation of the proposed sale.

Impact Analysis

Cancellation of the proposed sale would nullify any of the adverse impacts to all resources evaluated in Section IV.C. resulting from the exploration for, and development and production of sulphur/salt in the Central Gulf of Mexico. The 55 million long tons of sulphur (and the 15 million tons of salt needed to produce it) expected to be discovered and produced as result of the proposed action would continue to be replaced by imports of sulphur from Canada and Mexico. Adverse socioeconomic impacts incumbent with this alternative would include loss of employment opportunities, payroll revenues, and tax revenues. Potential economic benefits in the coastal region would be lost.

Conclusion

The adoption of this alternative would nullify all impacts, positive and negative, associated with the proposed action.

Cumulative Impacts

Cumulative impacts as discussed for all resources analyzed would remain essentially the same with only a small reduction of impacts that would result from this proposed action. Other cumulative impact producing factors (i.e. oil and gas industry, commercial and sport fishing activity, existing sulphur operations, hurricanes and other natural occurrences) would remain unchanged.

V. CONSULTATION AND COORDINATION

A. DEVELOPMENT OF THE PROPOSED ACTION

Following an expression of interest by the sulphur producing industry on expanding their offshore operations, MMS published in the *Federal Register* on June 3, 1986, a Request for Comments on the desirability of conducting a Federal OCS sulphur sale in the Gulf of Mexico. Respondents were further asked to provide information on production technology, stratigraphic test drilling, and possible leasing strategies. Responses were received from seven private sector and governmental organizations. Responses are summarized below.

Based on favorable comments received, MMS published a Call for Information and Nominations (Call) for the proposed action in the *Federal Register* on October 17, 1986. Of the 161 tracts nominated , MMS deleted 2 tracts which contain sensitive biological features, and the Area Identification (AI), consisting of 159 of the nominated tracts representing 754,798 acres, was approved by the Assistant Secretary for Lands and Minerals on December 30, 1986. Following subsequent analysis, the AI was further modified in June 1987 to delete six other tracts (two bidding units) which were adjacent to the same sensitive biological features. Therefore, 153 tracts in 51 bidding units representing 724,798 acres are being considered for offering in this proposed action.

B. DEVELOPMENT OF THE ENVIRONMENTAL ASSESSMENT

Although formal scoping is not required for an environmental assessment under OCSLA and CEQ guidelines, MMS decided to follow scoping procedures for contacting and coordinating with Federal, State, and local governments, institutions, public interest groups and concerned individuals throughout the development of this document. This decision was based on the nature and uniqueness of the proposed action. There were five major steps in this process:

(1) The Call publication and mailout which provided information for the AI as discussed above.

(2) Letters to the Governors of the affected states which provided an announcement of the issuance of the Call and provided further information.

(3) Requests for Information specific to offshore sulphur leasing were mailed on November 21, 1986.

(4) Following the AI decision on December 30, 1986, additional scoping letters were sent to the Governors announcing the results of the AI. These further solicited comments and recommendations on significant issues for analysis in the EA. A Fact Sheet with similar announcements/requests was sent to interested State and Federal agencies, industry, environmental groups, and individuals.

(5) Meetings:

  - A meeting was held with RTWG members of the States of Alabama and Florida in Mobile, Alabama, on September 30, 1986, which was also open to the public.
  - A meeting was held with the RTWG member for the State of Louisiana on October 24, 1986, in Baton Rouge, Louisiana, and a follow-up meeting was held on January 13, 1987, in New Orleans, Louisiana, following the AI.
  - A meeting was held with the RTWG member for the State of Texas on October 28, 1986, in Austin, Texas.

- A meeting was held with the Louisiana Department of Wildlife and Fisheries and the Louisiana Department of Environmental Quality on October 30, 1986, in Baton Rouge, Louisiana.

- An Endangered Species Consultation meeting was held on January 13, 1987, in New Orleans, Louisiana, as provided for under Section 7 of the Endangered Species Act. In attendance were representatives of USFWS, NMFS, and MMS. A brief history of the sulphur leasing process, a discussion of the proposed sulphur/salt leasing schedule, a brief discussion of sulphur mining procedures, and a discussion of impact producing factors were given at the meeting.

- A meeting with other DOI agency representatives was held in New Orleans, Louisiana, under the authority of DM 655 on January 14, 1987. Scoping efforts for the proposed sulphur/salt sale were conducted at this meeting and are described below.

MMS maintains an ongoing scoping process through the consultation and coordination of activities of individual staff members with counterparts in State and Federal agencies.

Request for Comments

A total of seven responses were received: three from oil and gas companies; two from sulphur processing companies; one from a Federal agency; and one from a State agency.

Exxon Company, U.S.A. - Exxon stated they had not experienced any incompatibility between their oil and gas operations in Grand Isle Block 18 and Freeport Sulphur Company's sulphur operations on adjacent blocks. Exxon does question priority of rights between hydrocarbon lessees and salt and sulphur lessees. Exxon felt that the priorities should be satisfactorily defined prior to salt and sulphur leasing acitivities. Exxon further emphasized that OCS hydrocarbon leasing, exploration, and production must not be unreasonably restricted by other non-energy mineral exploration and development. Exxon believed the Call should include requests for comments on proposed terms and conditions pertaining to priority use and correlative rights in the event of an OCS salt and sulphur lease sale.

Phillips Petroleum Company - Phillips opposed leasing of salt and sulphur in areas close to salt domes where active hydrocarbon leases exist. They stated exploration and production of sulphur/salt is incompatible with hydrocarbon development. Phillips expressed concerns about the potential dangers associated with the injection of spent waters from sulphur leasing operations into shallow aquifers including surface subsidence and casing failure from corrosion and over-pressuring the aquifer; concerns about the potential competition for available water in aquifers between oil and gas operations and sulphur/salt operations; and the concern that oil and gas leasing is of more strategic importance than other activities that may conflict.

Shell Offshore, Inc. - Shell stated that sulphur and salt extraction were not business opportunities that they want to pursue at the present time.

Burza International LTD. - Burza is a Canadian sulphur processing company with facilities in Galveston, Texas. Burza was very interested in expanding their sulphur supply and favored sulphur leasing. They requested all information regarding the project.

Freeport McMoran - Freeport has four existing sulphur leases on the OCS (Grand Isle Blocks 16, 17, 22, and 23). They favor sulphur/salt mining on the OCS and have recommendations regarding lease conditions including the size of leases, lease terms, royalty rates, and water depth limits. Freeport McMoran also commented on areas to be included in a Call (recommending the entire Federal domain offshore Louisiana up to a water depth of 400 ft, beyond which it was felt mining operations are economically unfeasible); technology proposed for exploration (normal formation identification means), production (the Frasch process), and transportation of sulphur to shore (pipeline, barge, and ship); the need for a prelease Deep Stratigraphic Test Program (not recommended); and the compatibility of oil and gas development and sulphur/salt operations (citing Freeport's present oil and gas operation being concurrently conducted on sulphur leases). Freeport also supplied data concerning the current and projected sulphur market.

U.S. Fish and Wildlife Service (FWS) - FWS limited its comments to the Central Gulf of Mexico Area only. They expressed concern of high sulfide concentration in bleedwater discharges from sulphur mining operations on fish and wildlife in the immediate area of discharge. FWS recommended environmental studies to assess the impacts of bleedwater discharges on biological resources prior to conducting a sulphur lease sale or allowing operational activities resulting from a lease sale. FWS feels the MMS Environmental Studies Program is an appropriate vehicle for the studies.

State of Mississippi - Mississippi's State Clearinghouse for Federal Programs commented that the State agencies reviewing the notice had no comments or recommendations.

Call for Information and Nominations

In addition to sulphur processing companies, a total of nine responses were received resulting from the Call: one from an oil and gas company; three from State governments; three from other Federal agencies; and two from environmental groups.

Sulphur Processing Companies - The sulphur processing companies submitted comments on leasing procedures, including suggestions on leasing less than full blocks, low minimum bids per acre, royalty rate recommendations, recommendations of the adoption of a workable lease form, suggestions on lease terms, and recommendations that salt leases be awarded with the sulphur leases.

Phillips Petroleum Company - Phillips firmly opposes the leasing of sulphur and salt in areas close to salt domes where there are existing active oil and gas leases. They believe that the injection of corrosive waters from sulphur leasing operations into aquifers penetrated by oil and gas wells could result in casing failures and collapse of casings due to overpressuring of the aquifer. Phillips further identified a potential resource conflict between oil and gas production vs. sulphur mining for the available water aquifer if seawater were not suitable for a particular operation.

State of Texas - Comments were received from the Texas Attorney General's Office, Texas General Land Office (GLO), Texas Parks and Wildlife Department (PWD), and the Texas Air Control Board (ACB). The Attorney General's Office expressed their opposition to areawide leasing and recommended a full EIS for the proposed action, addressing in particular the dangers to biological communities and topographic features, and the increase in coastal debris expected. GLO requested that the State of Texas be assured that its sulphur holdings adjacent to Federal waters be protected and reiterated its concerns regarding environmental protection during mineral development activities expressed for the last oil and gas EIS. PWD mentioned that its environmental concerns were expressed in the scoping process for the Draft EIS for the 5-year OCS Oil and Gas Leasing Program. They also indicated their continued commitment to minimizing impacts to sensitive areas and topographical features. ACB stated that no major contaminant emissions are expected from the proposed action, but that care should be taken to ensure no degradation from leaks, breaks, or blowouts. They further stated that establishment of onshore facilities would require a case-by-case assessment by ACB through its normal permitting procedures.

State of Mississippi - The Mississippi Bureau of Marine Resources expressed concern about the discharge of materials from nearshore sulphur activities which might affect the State's shallow coastal waters and their resources, particularly the "live bottoms." They also are concerned about the development and implementation of appropriate environmental stipulations and safeguards regarding the extraction activities. In the absence of physical oceanographic data, they feel that discharges could be allowed with a proper monitoring program if extraction activities were to take place near Mississippi's offshore territorial boundary.

State of Alabama - The Governor stated that although they expected no interest in sulphur leasing in Federal waters adjacent to the Mobile area, if there were interest expressed they would like the opportunity to meet with MMS and discuss that interest.

U.S. Army Corps of Engineers (COE) - COE stated that they had no additional information pertinent to sulphur leasing in the Gulf of Mexico.

U.S. Department of the Treasury - The Department of the Treasury stated that they have no additional information to provide on the environmental impacts of sulphur leasing in the Gulf of Mexico.

U.S. Fish and Wildlife Service (FWS) - FWS expressed the same concerns as for the Request for Comments, i.e., effects of bleedwater discharges, the lack of scientific data on those discharges, and the need for environmental studies prior to sulphur leasing or operations.

Natural Resources Defense Council (NRDC) - NRDC expressed the concern that the sulphur/salt sale is premature given the lack of updated, detailed regulations governing sulphur operations on the OCS. They feel that sulfide-laden discharges and spills from sulphur mining operations may pose a substantial threat to the marine environment. NRDC reflected Phillips Petroleum Company's concerns that injection of spent water could cause casings corrosion or collapse, thereby resulting in a major oil spill or discharges of corrosive sulfide-laden spent waters.

Sierra Club, Houston Regional Group - The Sierra Club expressed issues or topics that they feel should be addressed in an EIS. Those issues included: (1) the effects of turbidity, sulfates, heavy metals, brine, hydrocarbons, or any other pollutants generated by offshore sulphur mining; (2) the economic interaction or conflicts between offshore as opposed to onshore sulphur mining industries and any contrasts in environmental impacts; (3) deferral of tracts around the East and West Flower Gardens Banks; (4) the effects of mining on sport and commercial fisheries (including obstructions) and the effect on sea litter on Texas beaches; and (5) the effects and interactions of sulphur mining and oil and gas drilling - cumulative, direct, indirect, secondary, tertiary, synergistic, etc.

Area Identification

In response to the AI mailout, four comments were received: one from a State government, one from another Federal agency, and two from environmental groups.

State of Louisiana - The Governor of Louisiana responded that a description of transportation methods should be included in the discussion of facility construction. Another issue he felt should be addressed is the potential impact of operations on fisheries, and especially Louisiana net fisheries. The discussion should include the placement and abandonment of structures.

U.S. Fish and Wildlife Service - FWS had no comment on the area identified for sulphur leasing. They also feel that in addition to topics already identified, MMS should include an assessment of effects of sulphur mining activities on the topographic features.

Natural Resources Defense Council - NRDC expressed the strong belief that MMS must prepare an EIS instead of an EA for the proposed sulphur/salt lease sale.

Sierra Club, Houston Regional Group - Sierra Club also expressed the belief that an EIS instead of an EA should be prepared for the proposed sulphur/salt lease sale.

Summary of RTWG Meetings

On September 30, 1986, a meeting was held between MMS staff and RTWG members from the States of Alabama and Florida in conjunction with a public scoping meeting for both the EIS for Proposed Oil and Gas Lease Sales 113, 115, and 116, and for the EA for the Proposed Sulphur/Salt Lease Sale. No one from the public attended the meeting. The responses to the proposed sulphur/salt sale are as follows:

Dr. Ernest Mancini, RTWG member, State of Alabama - Any elemental sulphur offshore of Alabama would be greater than 20,000 ft in depth and of no commercial value. Alabama does produce a sizable quantity of sulphur through the reclamation process of hydrocarbons in the Mobile area. Production figures for 1983 through 1985 were presented to MMS staff.

Mr. Murice Rinkel, RTWG member, State of Florida - Florida would be essentially unaffected by the proposed sulphur/salt lease sale, and they had no comment.

On October 24, 1986, a meeting was held with the Louisiana RTWG member in Baton Rouge, Louisiana. Dr. Charles Groat and Ms. Virginia Van Sickle had the following comments: (1) Louisiana favors the EA process rather than going directly into an EIS for the proposed action. (2) Transportation options should be left open to potential bidders for their evaluation. Barges, they feel, would be less environmentally detrimental to coastal areas than pipelines. (3) Interest in a sulphur lease sale onshore or in State waters has not been too great. (4) They felt MMS should meet with representatives from the Department of Wildlife and Fisheries and Department of Environmental Quality. (5) They are not terribly concerned with elemental sulphur since it is relatively inert, but think MMS should address in the EA such issues as the toxicity of sulphur in water in case of a spill, the thermal impact of an accidental spill of molten sulphur, the safety aspects of hot barges (in case of a collision), impacts of onshore facility construction and dredging necessary for increased barge traffic, and the socioeconomic impacts.

On October 28, 1986, MMS staff met with the Texas RTWG member in Austin, Texas. Dr. Gerry Wermund expressed the following concerns: (1) If sulphur is found, how often would barges come into coastal facilities and how much water would they draw.? These figures would be used to calculate shoreline erosion. (2) If sulphur is found offshore of Texas, he feels Freeport, Texas, would be a likely site for an onshore facility. (3) He feels that another meeting needs to be held following the AI so that concerns can be expressed on a site-specific basis.

Another brief meeting was held in New Orleans, Louisiana, in January, 1987, at which Dr. Wermund had no further comment since all tracts in the AI were offshore of Louisiana.

On October 30, 1986, a meeting was held in Baton Rouge, Louisiana, between MMS staff and representatives of the Louisiana Department of Wildlife and Fisheries and the Louisiana Department of Environmental Quality. Concerns expressed included: (1) Sulphur is not considered a direct environmental pollutant since it is very stable, inert, and not soluble in water. (2) Drilling muds used in sulphur drilling should be controlled if they contain oil-base materials. (3) When stored in humid areas, bacteria may oxidize sulphur and form sulphur dioxide, an air pollutant. (4) Transportation of sulphur to shore from the mine site is best performed by surface vessels since this form of transportation has the lowest potential for environmental hazard.

Results of the DM 655 Meeting

The DM 655 meeting was held in the Leasing and Environment Conference Room at the MMS Gulf of Mexico OCS Regional Office in New Orleans, Louisiana, on January 14, 1987. In attendance were MMS staff Douglas Elvers, Jerry Brashier, Jesse Hunt, Charles Hill, Jake Lehman, and John Rodi. Allen Mueller represented U.S. FWS from Houston, Texas, and George Neusaenger represented NPS in New Orleans, Louisiana. James Barkuloo of FWS, Panama City, Florida, was briefed earlier by Jesse Hunt and had no comments.

Mr. Hunt and Mr. Elvers gave a description of the proposed action including the history of the sulphur leasing process to date, a discussion of the proposed schedule, a discussion of the impact producing factors, and a brief discussion of sulphur mining procedures. Mr. Mueller expressed concern over impacts to sensitive biologic features, marine mammals and turtles, endangered and threatened species, and coastal wetlands habitat. Mr. Neusaenger had questions concerning impacts to coastal wetlands, trash and debris on coastal beaches (particularly national parks and seashores), and impacts resulting from dredging activities in the coastal zone.

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Appendix A

Physical Properties of Elemental Sulphur

Sulphur is a tasteless, odorless, non-metallic element whose physical properties are listed below:

State: Normally solid.
Color: Yellow in its pure state, varying to yellow shades of gray, green, or red with impurities.
Melting Point (Normal): 118.9°C (246.1°F).
Solidification (Freezing) Point: 114.5°C (238.1°F).
Boiling Point: (At atmospheric pressure) 444.6°C (832.3°F).
Ignition Point: (In air) 270°C (511°F). Burns with a blue flame yielding sulphur dioxide.
Viscosity of Molten Sulphur: Fairly limpid at the melting point, becoming extremely viscous as the temperature approaches 188°C (370°F), and decreasing in viscosity at still higher temperatures.
Specific Gravity: 2.07 (in the form of rhombic crystal).
Hardness: 1.5 to 2.5 (Mohs' Scale).
Luster: Resinous, transparent to greasy.
Crystalline Form and Habit: Naturally orthorhombic dypyramidal commonly in irregular masses; thick and tabular; also massive, in spherical or reniform shapes; stalactitic, as incrustations, earthy. Changes to monoclinic crystals above 95.5°C (203.9°F).
Fracture and Tenacity: Conchoidal to uneven, brittle to imperfectly sectile.
Cleavage: None.
Streak: White.
Thermal Properties: Poor conductor of heat; crystals emit a crackling noise when warmed by hand.
Electrical Properties: Non-conductor of electricity; electifies negatively upon friction.
Solubility: Insoluble in water and acids; attacked by alkalies. Very soluble in carbon disulphide; various solubilities in organic liquids, generally increasing with temperature.
Atomic Number: 16.
Atomic Weight: 32.066
Natural Isotopes: 95.1% S^{32}, 0.74% S^{33}, 4.2% S^{34}, 0.016% S^{36}.
Chemical Valences: 2 (i.e., H_2S); 4 (i.e., SO_2); 6 (i.e., SO_3).

Occurrence and Recovery: Large quantities of elemental sulphur occur in the cap rock of some salt domes of the Texas-Louisiana Gulf coastal region. Fewer than 10% of the salt domes so far discovered have been found to contain commercial quantities of sulphur. This sulphur occurs in cavernous calcite zones of the cap rock that are typically sealed above by dense limestone and below by a layer of anhydrite which occurs immediately above the salt. Anhydrite (calcium sulfate) is an evaporite mineral deposited from the evaporation of sea water and is commonly associated with salt deposits. A large, thick bed of salt underlies the Gulf coastal area of Texas and Louisiana and is buried beneath about 20,000 ft of sediments along the coastal area. The pressure of this overburden causes the salt to become semi-fluid and, due to its lesser density, it forces its way upward through weaknesses in the overlying sediment (along with any anhydrite it contains) forming salt domes. As the rising domes encounter ground water, some of the salt is dissolved leaving a residual cap of anhydrite. It is believed that as the cap rock encounters hydrocarbon-bearing formations, the sulfate-reducing bacteria, *Desulfovibrio desulfricans*, present in the petroleum attack the sulfate in the anhydrite and generate hydrogen sulfide (H_2S) gas. A false cap rock of impervious clays or shales must be present to trap the gas. It is believed that the elemental sulphur is formed from the oxidation of the trapped hydrogen sulfide gas. Elemental sulphur is also frequently found in regions of recent volcanic activity where it is deposited directly from the sublimation of volcanic gases and, possibly, from the incomplete oxidation of hydrogen sulfide from volcanic sources or in thermal spring waters. Other occurrences of sulphur are found in sedimentary rocks of Tertiary age associated with gypsum, calcite, bituminous limestone, or cellular limestone in such areas as West Texas, USSR, Sicily, and other parts of Europe. Sulphur is mined from salt domes by pumping in superheated water to melt the sulphur, which is then pumped to the surface (Appendix B). Conventional mining techniques are used on some sedimentary-associated sulphur. Large quantities of sulphur are recovered from smelter gases and from sour (H_2S-bearing) oil and natural gas. Sulphur is also recovered from the processing of pyrite (iron sulfide).

Sources: Berry and Mason, 1959; Haynes, 1959; and Sweet, 1986.

Appendix B

Description of the Frasch-Mining Process for Sulphur